U.S. Robotics®

COURIER HST™ MODEM

9600/2400/1200/300 BPS, AUTO DIAL, AUTO ANSWER MODEM
WITH USR HST™ ERROR CONTROL

USER'S MANUAL

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Limited Warranty viii
FCC Registration ix
Connecting to the Telephone Company ix
Radio and Television Interference x
For Canadian Modem Users xi
How to Use this Manual xii

PART I. INSTALLATION AND OPERATION

CHAPTER 1—Introduction 1-1

Advanced Features 1-1
The Courier Product Family 1-2
Courier HST Compatibility 1-3

CHAPTER 2—Set-Up and Testing 2-1

Package Components 2-1
Operational Requirements 2-1
Assembling the Modem 2-2
Testing 2-5

CHAPTER 3—Operations at a Glance 3-1

Data Format 3-1
Error Control 3-1
Data Compression 3-1
Dialing 3-1
HST-Compatible, 9600 bps 3-1
MNP-Compatible, 2400 or 1200 bps 3-1
Non-MNP Compatible, 2400, 1200, 300 bps 3-2
Flow Control 3-2
Maximum Throughput 3-2
High-Speed Channel Turnaround 3-2
Link Negotiation 3-3
Data Rate Defaults 3-3
Nonvolatile Memory (NRAM) 3-3
Phone Number Storage 3-3
Dialing Stored Numbers 3-4
Busy Answer 3-4
Inactivity Timer 3-4

CHAPTER 4—Interface Controls 4-1

Terminology 4-1
Throughput Guidelines 4-1
Error Control 4-2
ARQ Retry Timeout 4-2
Online Data Rate Fallback 4-3
Error Control Modes (&M*n*) 4-3
With Auto Answer 4-4
Data Compression Mode (&K*n*) 4-4
Flow Control 4-5
Transmit Data Flow Control (&H*n*) 4-5
Hardware Control 4-5
Software Control 4-6
Received Data Flow Control 4-6
Hardware Control (&R*n*) 4-6
Software Control (&I*n*) 4-7
Data Rate Commands 4-8
Variable Rates 4-8
Fixed Rates 4-9
Maximum Throughput Settings 4-9
DTE Rate Select (&B*n*) 4-9
Link Rate Select (&N*n*) 4-9
DSR Override (&S*n*) 4-10

CHAPTER 5—Internal Controls 5-1

Setting/Using Defaults 5-1
Writing Defaults to NRAM (&W) 5-1
Loading the Factory Defaults (&F) 5-2
Resetting to NRAM Defaults (Z) 5-2
Storing Telephone Numbers (&Z*n*=*s*) 5-2
Result Codes 5-3
Response Modes (V*n*) 5-3
Result Code Sets (X*n*) 5-3
Result Codes Options Table 5-4
Options Summary 5-4
Quiet Mode (Q*n*) 5-5
/ARQ Result Codes (&A*n*) 5-5
Local Echo 5-5
Command Mode Local Echo (E*n*) 5-5
Online Local Echo (F*n*) 5-6
The Audio Monitor 5-6
Speaker Control (M*n*) 5-6

Modem Clock Usage (K*n*) 5-7
Transmitter Enable/Disable (C*n*) 5-7
Break Handling (&Y*n*) 5-8
The S-Registers 5-8

CHAPTER 6—Dialing and Answering 6-1

Basic Requirements 6-1
Transmission Rate 6-1
Error Control 6-1
Automatic Retrain 6-2
Placing Calls 6-2
Dial (D) 6-2
Dialing Type, X0 or X1 Setting 6-2
Adaptive Dialing, X2–X7 Settings 6-3
Pause (,) 6-3
Dial and Return to Command Mode (;) 6-4
Dialing Letters (‘‘) 6-5
Transferring Calls (!) 6-5
Wait for a Second Dial Tone (W) 6-5
Wait for an Answer (@) 6-5
Reversing Originate/Answer Frequencies (R) 6-6
Canceling Dialing 6-6
Redialing 6-6
Re-execute the Last Command (A/) 6-6
Automated Redialing 6-7
Continuous Repeat (>) 6-7
Continuous Re-execute (A>) 6-7
Exiting Repeat Mode 6-7
Dialing a Stored Number (DS*n*) 6-7
Escape Code Operations (+ + +) 6-8
Modem Response to + + + 6-8
Returning Online (O) 6-9
Hanging UP (H*n*) 6-9
Automatic Answering 6-9
Suppressing Auto Answer 6-10
Points to Remember 6-10
International Calls 6-10
U.S./CCITT Answer Tone (B*n*) 6-10
Guard Tone (&G*n*) 6-10
Pulse Dial Make/Break Ration (&P*n*) 6-11

CHAPTER 7—Queries and Help Screens 7-1

User Inquiries (I*n*) 7-1
S-Register Query (S*r*?) 7-1
S17 7-4
S20 7-4
Phone Number Query (&Z*n*?) 7-4
Help Screens 7-4
Basic Command Set ($) 7-4
Extended Command Set (&$) 7-5
S-Register Functions (S$) 7-6
Dialing (D$) 7-6

PART II. REFERENCE

APPENDIX A—Error/Flow Control Concepts A-1

MNP Level Negotiation A-1
Throughput A-1
Level 1 A-1
Level 2 A-2
Level 3 A-2
Level 4 A-2
Level 5 A-3
Error Detection/Retransmission A-3
Flow Control A-4
Example 1—Transmit Data A-5
Example 2—Received Data A-5

APPENDIX B—Summaries and Tables B-1

The RS-232C Interface, with Pin Definitions B-1.1
Front End Indicators B-2.1
DIP Switch Summary B-3.1
Default Settings B-4.1
S-Register Summary B-5.1
ASCII Chart B-6.1

APPENDIX C—Alphabetical Command Summary C-1

APPENDIX D—Problems and Solutions D-1

If You Still Have Problems D-3

APPENDIX E—Additional Operational Information E-1

Using Both Voice and Data Communications E-1.1
High Speed/Low Speed Protocol E-2.1
Retrain Sequence E-3.1
PBX, Dedicated Line, and Leased Line Operations E-4.1
Hewlett Packard Installations E-5.1
Analog Loopback and Other Tests E-6.1

APPENDIX F—Technical Specifications F-1

GLOSSARY G-1

INDEX

LIMITED WARRANTY

U.S. Robotics, Inc., warrants to the original consumer or other end user purchaser that this product is free from defects in materials or workmanship for a period of two years from the date of purchase. During the warranty period, and upon proof of purchase, the product will be repaired or replaced (with the same or similar model) at our option, without charge for either parts or labor. This warranty shall not apply if the product is modified, tampered with, misused, or subjected to abnormal working conditions.

REPAIR OR REPLACEMENT AS PROVIDED UNDER THIS WARRANTY IS THE EXCLUSIVE REMEDY OF THE PURCHASER. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR PURPOSE, AND U.S. ROBOTICS SHALL IN NO EVENT BE LIABLE TO PURCHASER FOR INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND OR CHARACTER.

Some states do not allow the exclusion or limitation of incidental or consequential damages or allow limitations on how long an implied warranty lasts, so the above limitations or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

To obtain service under this warranty, contact the U.S. Robotics Technical Support Department at 800/982-5151 (in Illinois, 312/982-5151), or by mail at 8100 North McCormick Blvd., Skokie, Illinois, 60076. You will be given a Return Materials Authorization (RMA) number to help us keep track of your warranty request. Once you have received your RMA number, take or mail the product, postage prepaid, to U.S. Robotics at the above address. Include proof of the date of purchase. IMPORTANT: If you ship your unit, pack it securely, be sure your RMA number is visible on the outside of the package, and ship it charges prepaid and insured.

➤ Should you encounter problems in operating this device, follow the instructions in Appendix D in Part II of this manual. The Appendix contains solutions to operating problems as well as procedures to follow if there is an apparent modem malfunction.

FCC REGISTRATION

FCC68: CJE794-11323-DM-E
RINGER EQUIVALENCE: 0.4B
FCC15: CJE794FAST

CONNECTING TO THE TELEPHONE COMPANY

It is not necessary to notify the telephone company before installing the modem. However, the telephone company may request the telephone number(s) to which the Courier is connected and the FCC information printed above.

If the telephone company has any questions or raises problems, ask them to call the Technical Support Department, USRobotics, Inc., 800/982-5151 (in Illinois, 312/982-5151).

If the modem is malfunctioning, it may affect the telephone lines. In this case, disconnect the modem until the source of the difficulty is traced. Do not use the modem on party or coin telephone lines.

RADIO AND TELEVISION INTERFERENCE

This equipment generates and uses radio frequency energy and if not installed and used properly, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. The Courier HST has been tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference in a residential installation.

However, there is no guarantee that interference will not occur in a particular installation. If this device does cause interference to radio or television reception, which you can determine by monitoring reception when the modem is on and off, try to correct the problem with one or more of the following measures.

Reorient the receiving antenna.
Relocate the computer with respect to the receiver.
Relocate the computer and/or the receiver so that they are on separate branch circuits.

If necessary, consult your dealer or an experienced radio/television technician for additional suggestions. You may find the following booklet, prepared by the Federal Communications Commission, helpful:

How to Identify and Resolve Radio-TV Interference Problems
Stock No. 004-000-0345-4
U.S. Government Printing Office
Washington, DC 20402

FOR CANADIAN MODEM USERS

The Canadian Department of Communications (DOC) label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational, and safety requirements. The department does not guarantee the equipment will operate to a user's satisfaction.

Before installing this equipment, make sure you are permitted to connect it to the facilities of the local telecommunications company. You must also install the equipment using an acceptable method of connection. In some cases, you may also extend the company's inside wiring for single line individual service by means of a certified connector assembly (telephone extension cord). You should be aware, however, that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designated by the supplier. Any repairs or alterations made by a user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

For your own protection, make sure that the electrical ground connections of the power utility, telephone lines, and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

CAUTION: Do not attempt to make such connections yourself; contact the appropriate electric inspection authority or electrician.

Courier HST Modem Load Number: 38B

The Load Number (LN) assigned to each terminal device denotes the percentage of the total load to be connected to the telephone loop used by the device, without overloading. The termination on a loop may consist of any combination of devices, subject only to the requirement that the total of the Load Numbers of all the devices not exceed 100. An alphabetic suffix is also specified in the Load Number for the appropriate ringing type (A or B), if applicable. For example, LN = 38B designates a Load Number of 38 and a B-type ringer.

HOW TO USE THIS MANUAL

This manual is divided into two parts. The first part is designed to aid you in getting your modem connected and operating as quickly as possible. Part I also includes chapters on command usage. Part II contains a number of informative appendixes that you may or may not need, depending on your situation, plus a Glossary and Index.

Below is a brief description of the manual's contents. We suggest you review at least Chapters 1-3 before operating the modem.

- Chapter 1—Introduction
- Chapter 2—Assembling and testing the modem
- Chapter 3—Immediate operations—essentials
- Chapter 4—Interface controls
- Chapter 5—Internal controls
- Chapter 6—Calling, answering and disconnecting
- Chapter 7—Inquiries and Help screens

The appendixes in Part II cover the following subjects:

- Background information on error and flow control
- Summaries and tables
- Problems, their causes, and solutions
- Additional operational information
- Technical specifications

Whenever a cross-reference is made to the same or a similar subject, you'll be directed to the appropriate section of the manual with this arrowhead symbol, ➤.

ADVANCED FEATURES

The USRobotics Courier HST modem represents powerful, advanced electronic design that gives you optimal speed and accuracy.

Trellis Coded Modulation

Trellis coded modulation is a convolutional coding technique that makes data transmission less vulnerable to errors caused by phone network impairments. It can tolerate twice the telephone channel noise power as conventional modulation (quadrature amplitude modulation, or QAM), so there are fewer error-control retransmissions. Trellis coded modulation is also less susceptible to impulse-type noise.

Asymmetrical Modulation

At top speed, data flows in one direction at 9600 bits per second and at 450 bits per second in the other. The modems automatically switch the high-speed channel on demand, i.e., depending on which transmitter has the most data to transmit.

In practice, the modems seldom need to reverse channels, since the asymmetrical design reflects typical communications sessions—brief messages typed at one end of the link, files sent from the other. The asymmetrical approach provides the most efficient and economical strategy for using ordinary phone channels at high speeds.

Error Control

The MNP protocol is a widely used, sophisticated method of ensuring data integrity at 2400 and 1200 bps. A USRobotics proprietary protocol similar to MNP is used at 9600, 7200 and 4800 bps. With error detection and retransmission of errored data blocks, plus flow control, you can be assured that your data is sent and received with reliability.

Data Compression/ Throughput Gains

The Courier HST compresses data to pack more information into each second of your calls, enabling throughput of up to 19.2k bits per second. In addition, the implementation of larger data transmission blocks eliminates much of the added overhead (protocol information) associated with less powerful error-control protocols.

Rate Selection/ Flow Control

The Courier HST modem's flow control buffer allows you to set your computer/modem rate as high as 19.2k bits per second, for even greater performance. Flow control settings protect transmissions from data loss.

Online Fallback/ Fall Forward

During 9600-bps communications, if severe line impairments threaten the integrity of data transfer, the modems fall back and retrain at 7200 bps. If necessary, they fall back further to 4800 bps. As line improvements occur, the modems automatically shift up to the next higher speed.

Programmable Nonvolatile Memory

You can tailor your own default settings for the Courier HST and store them in nonvolatile random access memory (NRAM). Each time the computer is powered on, the modem operates at the settings you've specified.

Diagnostics

After each call, you can display a Link Diagnostics screen containing information about the call. Two S-Registers also store information on the reason for a call's disconnect.

Shorter Response Time

9600-bps modems are generally most efficient for file transfers. You'll find that the Courier HST also offers faster response times during interactive sessions.

THE COURIER PRODUCT FAMILY

In addition to the Courier HST's new features, the modem incorporates the same popular capabilities of other products in the Courier line:

Link Negotiation Fallback

The Courier HST automatically falls back to 2400, 1200, and 300 bits per second, in both Originate and Answer Modes, to match a lower rate of a remote modem. You can optionally set local interface and link rates at fixed speeds.

Inactivity Timer

You can set the modem to automatically hang up after a specified number of minutes if there is no activity on the phone line.

Call Duration Reporting

The modem records the duration of your calls in hours, minutes, and seconds. This feature enables you to display and print an audit of your calling activities. You can optionally use the modem clock as a real-time clock.

Call Progress Detection

An optional set of result codes (screen messages) lets you know when a line is busy, a person rather than a modem has answered the phone, there is no dial tone, or the distant phone is ringing.

Modem Settings Display

On command, the modem displays its current settings, a handy way to check your transmission rate, S-registers and other operational controls.

HELP Screens

You can also display screens that summarize the command sets, Dial command options, and S-register functions.

Bottom Panel Reference

Operational summaries and other information are printed on the bottom of the modem case. A Dual In-Line Package (DIP) switch guide makes it easy to tailor the switch settings to your requirements.

Automated Redialing

You can put the modem into Repeat Mode to automatically redial if a previous dial attempt fails to connect. This is especially useful in dialing services whose lines are often busy.

Quote Mode

Set the modem to Quote Mode if you want it to dial an alphabetic "number," such as 800-"DIAL USR" (USRobotics' Sales Department).

Adaptive Dialing

You can set the modem to first try Touch-Tone dialing. If tone dialing doesn't work on the line, the modem automatically switches to the slower type, pulse (rotary).

Automatic Retraining

Retraining (a resynchronization with the remote modem) occurs if the modem detects line disturbances that might affect data reliability. Retraining occurs at 9600 and 2400 bps. (➤ Appendix E-3 contains more information.)

COURIER HST COMPATIBILITY

The Courier HST offers upgrading to 9600 bps while maintaining compatibility with most installed 2400/1200/300 bps, dial-up modems and existing software. Its compatibility features include the following:

- Can be used with any computer or terminal that is compatible with the RS-232C standard interface. (➤ For more information on the RS-232C interface, see Appendix B-1.)
- Can be used with any computer or terminal that uses ASCII, the standard character code supported by most equipment manufacturers.
- Connects with any modem whose signal scheme is compatible with the following standards at the given data rate:

300 bps	Bell 103
1200 bps	Bell 212A
2400 bps	V.22*bis*
9600 bps	USR-HST

- Uses the HST error control protocol at 9600 bps and the MNP error control protocol, Service Levels 1–5, at 2400/1200 bps.
- Is fully FCC-certified for the uses described in this manual.

CHAPTER 2
SET-UP AND TESTING

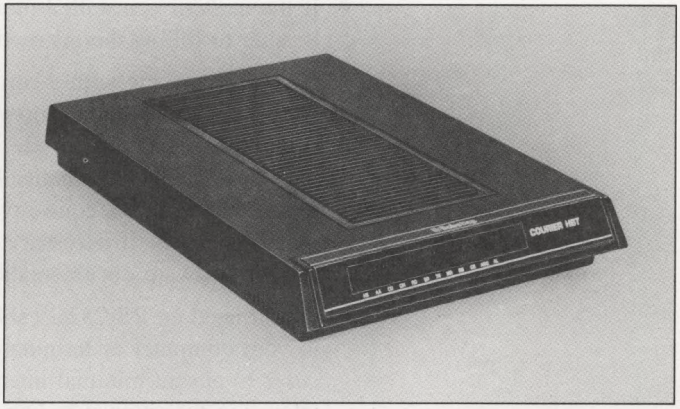


Figure 2.1—Courier HST

PACKAGE COMPONENTS

The box containing your Courier HST contains the following items in addition to this manual:

- The Courier HST modem
- An RJ11C phone cord
- A power adapter
- A Quick-Reference card, in the manual
- Your warranty card, to be filled out and returned to USRobotics, Inc.

OPERATIONAL REQUIREMENTS

The Courier HST has minimal operational requirements. Be sure to read the information in the front of this manual about radio and television interference and connecting to the phone company. In addition, you should be aware of the following:

- Follow the operating instructions in Appendix E-4 if the modem is to be used in either of the following types of installation.

  1) The modem will be installed in a key system PBX in which RJ12 or RJ13 telephone jacks are used rather than the RJ11 jack.

  2) The modem will be attached to a user-installed phone line or a line leased from the telephone company. Often referred to as ''dedicated'' or ''private,'' this type of line is used for a direct,

continuous connection between two modems. The connection is made without dialing.

- If the modem is installed in a Hewlett Packard system, be sure to follow the instructions in Appendix E-5.
- If you're working with a computer rather than a terminal, communications software is required to put the computer in Terminal Mode. Some communications programs do this automatically when you load the program, while others require typing a function key or other operation. If necessary, refer to your communications software documentation for instructions.
- You'll need an RS-232C cable to connect the modem to your computer or terminal. It should be a *shielded cable* to ensure minimal interference with radio and television reception. (➤ For information on the RS-232C interface, see Appendix B-1.)

  The modem takes a DB-25P (25-pin plug) connector, but computer equipment varies: check the serial port at the rear of your machine. The port will be labeled "Modem," "Communications," or "EIA," or with a phone symbol. (Don't use the port marked "Printer" or "Aux.") If the port is a plug, specify a DB-25S (socket) connector to your dealer. If the port is a socket, specify a DB-25P (plug) connector. If your machine has other than a 25-pin port, check your documentation to see what type of RS-232C connector is required.

ASSEMBLING THE MODEM

1. Turn off the computer or terminal and its peripheral devices.
2. Examine the label on the bottom of the modem. In addition to the summaries and other information, the label contains icons to aid in modem assembly. Then check the interfaces at the back of the modem, shown in the following photograph.

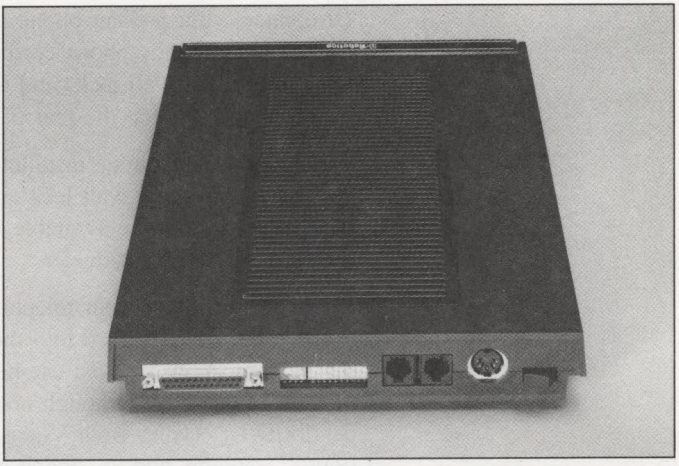


Figure 2.2—Interface End, Courier HST

3. Now review the attached interfaces in Figure 2.3.

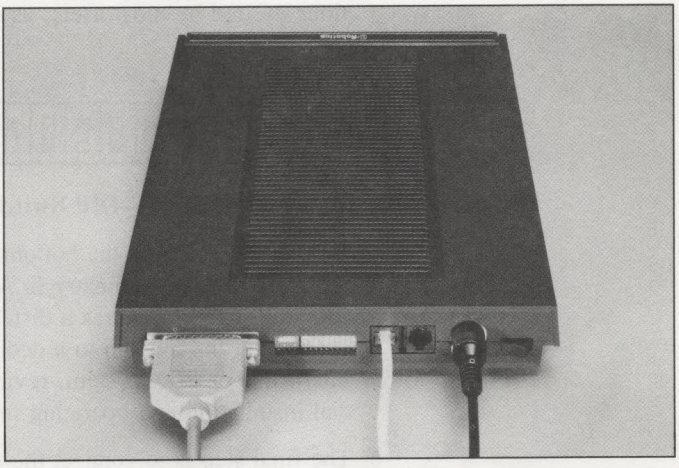


Figure 2.3—Connected Courier HST

4. Check to make sure that the power switch is OFF: press it towards the zero in the 1/0 icon on the bottom label. Then plug the small end of the power supply cord into the power jack at the back of the modem, and plug the power adapter into a standard 115-volts AC wall socket.

Disconnect your present phone cable from the wall jack. Plug one end of the phone cord that came with the modem into the wall jack, and the other end into one of the phone jacks at the rear of the modem.

NOTE: Older telephone installations may not have the appropriate modular wall jack and plug. Adapters and RJ11C connectors are available from your telephone company or computer dealer.

If you want to keep your telephone connected for conventional calls, plug its cord into the other jack at the rear of the modem. You can also use both your telephone and modem in one call, although not at the same time. ➤ Appendix E-1, "Using Both Voice and Data Communications," explains how to switch control of the phone line between the modem and the phone.

5. Next, check the positions of the bank of Dual In-Line Package (DIP) Switches located at the back of the modem. These switches are set at the factory to the positions desired by most users, as shown in Figure 2.4.

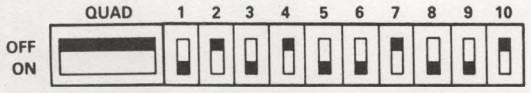


Figure 2.4—DIP Switch Factory Settings

➤ Use the guide on the bottom of the modem or refer to the more detailed summary in Appendix B-3 to determine if your situation requires a different setting. If you're connecting the modem to a dedicated line or to a small interoffice or PBX system, review Appendix E-4 for special installation and operating instructions.

6. The final step is to connect the modem to the computer's or terminal's serial port with the RS-232C cable described earlier under "Operational Requirements." Attach the appropriate connectors to the modem and to the serial port.

NOTE: When you are using the modem, be sure not to cover the vents on the top of the case.

The modem is now ready to be tested and operated.

TESTING

To verify that your modem is working properly, follow these steps:

1. Turn on your computer or terminal and clear the screen. Then turn the Courier's power switch ON. These front indicator LEDs will light up:

   CD Carrier Detect (if you haven't changed the factory setting of DIP switch 6)
   TR Data Terminal Ready (if you haven't changed the factory setting of DIP switch 1)
   MR Modem Ready/Power
   RS Request to Send, if your computer/terminal supports RTS on the RS-232C interface
   CS Clear to Send

2. If you're using a personal computer, load your telecommunications software and put your computer in Terminal Mode. This causes the computer to function as a terminal rather than a processor: everything you type at the keyboard goes directly to the modem. If necessary, refer to your communications software documentation for instructions.

3. Next, check to see if your machine and modem are communicating with each other by entering the command to get the modem's "attention." (Type either upper or lower case letters, not a combination. In this manual, the Carriage Return or Enter key required to issue commands is represented by the symbol <cr>. Don't type the angle brackets.)

   Type the following:

   AT <cr>

   If everything is correct, the modem responds as follows:

   OK

   NOTE: The AT command is used alone to check the modem/terminal interface. AT is also the mandatory prefix for all other commands except A/ and A>, used to repeat execution of the command in the command buffer, and + + +, the escape code. These exceptions are explained in Chapter 6.

4. The modem is shipped with DIP switch 4 UP, causing the modem to display (echo) your keyboard commands. If your typed command is not displayed, your local echo is OFF. To turn the local echo ON, send the modem the following command.

   ATE1 <cr>

   If double characters appear on the screen, both your modem and software are set to local echo ON. Either set your software to local echo OFF, or turn the modem's echo OFF with this command:

   ATE0 <cr>

5. If no OK appears on your screen, check out the connections at the interface end of the modem. Then carefully review the previous instructions to see if you've missed something.

For information on other testing such as the Analog Loopback self-test, see Appendix E-6.

CHAPTER 3
OPERATIONS AT A GLANCE

Here are some brief guidelines for immediate operation of the modem.

DATA FORMAT

Ten-bit data units: check the table on page 6-1 or page F-1.

ERROR CONTROL

Both modems must be set to error control mode for error detection and retransmission to occur. *Always use error control for 9600-bps communications.*

We use the term ARQ (automatic repeat request) for error control. The three ARQ settings are as follows:

&M0

Normal Mode. No error control.

&M4

Normal/ARQ Mode—Default. The Courier attempts an ARQ connection; if the signal isn't recognized, the modem continues in Normal Mode (&M0).

&M5

ARQ Mode. The Courier attempts an ARQ connection; if the signal isn't recognized, the modem hangs up.

DATA COMPRESSION

The modem is set at the factory to negotiate for data compression. Leave the modem set to its default *unless you are transferring files that are already compressed,* in which case you should disable data compression by setting the modem to &K0. For more information, see the throughput guidelines at the beginning of Chapter 4 and the &K command description in that chapter.

DIALING

Use the following settings/commands to call the specified type of modem at the indicated speeds.

HST-Compatible, 9600 bps

Terminal/software: 19.2k (preferable) or 9600 bps

Type:

AT &H3 D phone number <cr>

The command includes the setting for hardware/software flow control (&H3). See the flow control guidelines that follow. If the modem isn't set for error control, include &M4 or &M5 in the command line.

MNP-Compatible, 2400 or 1200 bps

Terminal/software: 19.2k, 9600, 2400 or 1200 bps

Type:

AT &H3 D phone number <cr>

The command includes the setting for hardware/software flow control (&H3). See the flow control guidelines that follow.

Non-MNP Compatible, 2400, 1200 or 300 bps

See the flow control guidelines that follow.

Terminal/software: 2400, 1200 or 300 bps

Type:

AT &MØ D phone number <cr>

NOTE: &MØ suppresses the MNP signals that may be misinterpreted by the remote system and prevent a successful connection.

FLOW CONTROL

Hardware and/or software flow control can be used for transmitted and received data. We recommend hardware flow control since it doesn't affect the data stream. This is especially important if you're transmitting binary data.

Transmit Data flow control (&H) is required in the following situations. Received Data flow control is optional.

- You're using error control (9600/2400/1200 bps). Flow control prevents buffer overflow in the event that line disturbances cause frequent retransmissions.
- You're using data compression.
- The rate at the local terminal interface is higher than the link rate.
- The volume of data transfer is high.

Flow control commands are covered in Chapter 4.

MAXIMUM THROUGHPUT

Use these settings for both Originate and Answer Modes. The default data compression setting, &K1, is assumed.

Terminal/software:	19.2k bps
Modem:	Fixed terminal interface rate (&B1) Variable link rate (&NØ) Transmit Data flow control (&H1 preferred, &H2 or &H3)

HIGH-SPEED CHANNEL TURNAROUND

As described in Chapter 1, HST modems use asymmetrical modulation. The modems allocate the high-speed channel on demand so that the modem with the greatest amount of data in its buffer transmits at 9600 bps.

Turnaround of the channel is automatic and requires no user intervention. If the remote modem has a 300-bps back channel, the Courier automatically drops its back channel rate from 450 to 300 bps.

LINK NEGOTIATION

When a Courier HST calls an HST-compatible modem and both are operating at 9600 bps, the modems negotiate the link connection (''shake hands'') at 2400 bps and automatically resume operation at 9600 bps. The lower handshaking rate maintains compatibility with the existing telephone network as well as existing hardware and software.

It's possible for two HST-compatible modems to connect directly at 9600, without 2400-bps handshaking, but *both modems* must be set as follows:

Terminal/software:	9600 or 19.2k bps
Modem:	Fixed link rate of 9600 bps (&N6) Error control, either &M4 or &M5

DATA RATE DEFAULTS

Terminal interface:	&BØ, detect rate from the AT command, then follow connection rate.
Link interface:	&NØ, negotiate the highest possible rate with the remote modem in both Originate and Answer Modes.

The terminal interface and link rates may be set to fixed rates using &B1 and &N1–6, respectively.

NONVOLATILE MEMORY (NRAM)

The modem is factory set (DIP switch 10 OFF) to load the settings stored in NRAM on power up. Write your own configuration defaults to NRAM with the &W command. To review the NRAM settings, refer to Appendix B-4 or send the modem the I5 option of the Inquiry command:

ATI5 <cr>

PHONE NUMBER STORAGE

Use &Z*n* = *s* to store four frequently called phone numbers in NRAM (nonvolatile memory); *n* = positions Ø through 3, *s* = number-string. The string may contain a maximum of 36 characters and any Dial command options.

Example: AT&Z = 9,,1 312 5551234 <cr>
(Store at position Ø)

Example: AT&Z1 = 5551234 <cr>
(Store at position 1)

DIALING STORED NUMBERS

To dial, issue the DS*n* command, where *n* indicates the position of the number in NRAM.

Example: ATDS1 <cr> (Dial number at position 1)

The first command in the following sequence stores the phone number and access code for a long distance service. The second command dials the stored number/access code and continues dialing the long distance phone number.

```
AT&Z2 = 5551234,,9876,, <cr>
ATDS2 D1 312 5556789 <cr>
```

BUSY ANSWER

Use A> instead of A/ and the modem redials up to 10 tries instead of once. Neither A> nor A/ takes the AT prefix or a Carriage Return.

Add the Repeat Mode command (>) to the Dial command string and the modem automatically redials up to 10 tries:

```
AT>D5551234 <cr>
ATD5551234> <cr>
```

You may include the Repeat command when you store a phone number-string in NRAM:

```
AT&Z2=5551234> <cr>
```

INACTIVITY TIMER

Set the inactivity timer (S-Register 19) if you suspect that a connection may be inadvertently left open without data transfer.

CHAPTER 4
INTERFACE CONTROLS

Use the commands explained in this chapter to select the modem's operating characteristics at the terminal and link interfaces. The commands apply to error and flow control, and to the speed-select options at both interfaces. ➤ For background information on these features, see Appendix A.

NOTE: When you change a default setting during a session, the modem retains that setting until you do one of the following:

- Select a new setting.
- Issue the Z command to reload the NRAM defaults or the &F command to load the factory settings.
- Turn the modem off.

TERMINOLOGY

For simplicity, references to a *terminal* in this chapter mean both conventional terminals and microcomputers. *ARQ* (automatic repeat request, i.e. retransmission) is the term used by USRobotics in error control commands and response codes.

In addition, the terminal is referred to as *DTE*, for Data Terminal Equipment, while the modem is referred to as *DCE*, for Data Communications Equipment. DTE/DCE indicates the terminal/modem interface.

THROUGHPUT GUIDELINES

The following guidelines should help you to make the most of the Courier HST modem's advanced performance features. In many instances, experimentation and experience will indicate what works best for your applications.

1. You'll attain optimal throughput under the following conditions:

   - Your communications software allows fixing the DTE rate higher than the link rate, e.g., setting the terminal/software to 19.2k bps and setting the modem to &B1.

     If your software automatically switches bit rates to follow the connection (link) rate (9600, 2400, 1200 or 300 bps), the DTE rate must be set to &BØ, and your throughput will be reduced.

   - The call is under MNP Level 3 error control, the longer transmission frames of MNP Level 4, and the

data compression of MNP Level 5. See Appendix A for comparative throughput information on each successive MNP level.

- Throughput is slightly higher for text files than for binary files such as .EXE or .COM files. For a comparative table, see *Level 5* in Appendix A.

2. Files that are already compressed become larger when subjected to further data compression. An example is the .ARC files downloaded from many BBS's. Another is random 8-bit binary files, which appear to the modem to be compressed. To avoid a decrease in throughput when transferrring these and similar files, we recommend disabling data compression (&KØ).

3. Many non-text files require a file transfer protocol, with varying throughput results. For example, certain public domain file transfer protocols have the following effects:

   XMODEM — Throughput is severely reduced, regardless of the Courier's performance features, due to XMODEM's short block lengths (128 bytes) and overhead (error control protocol information).

   YMODEM — There is an improvement over XMODEM, due to larger block lengths (1k bytes), but throughput is still reduced by the protocol's error control overhead.

   YMODEM-G and ZMODEM are better choices, YMODEM-G being the most efficient. These protocols assume the modems are handling error control: overhead is minimal, with throughput almost equal to throughput with no file transfer protocol.

ERROR CONTROL

While error control is optional, it should always be selected for 9600 bps sessions. The error control protocol uses cyclic redundancy checking for error detection, and an automatic repeat request (ARQ) for retransmission of errored data frames (transmission blocks).

ARQ Retry Timer

It may happen that a retransmission request for the same frame occurs repeatedly. Ordinarily this is due to a serious disturbance in the phone connection. The retry maximum is 12, after which the modems automatically hang up instead

of running up wasteful phone charges. If the Courier hangs up and you don't know why, query register S20 with this command:

ATS20? <cr>

If a code of 6 is returned, the modems reached the retry timeout and hung up. Place the call again; you'll more than likely get a better connection.

Online Data Rate Fallback

On 9600-bps MNP connections, to help avoid an automatic disconnect due to the retry timeout just described, the modems automatically fall back to 7200 bps. If necessary, they fall back again to 4800 bps. As soon as they sense line improvements, the modems shift back up to the next higher speed.

Online fallback is designed to keep you online at high speeds despite phone line impairments. This feature has the following characteristics:

- Online fallback has no effect on the DTE rate set with the &B command.
- The link rate must be set to &NØ (variable rates). If set to 9600 bps (&N6), the modem remains fixed at that rate. A setting of 7200 bps (&N5) or 4800 bps (&N4) disables online fallback.
- During retraining down to the next lower speed, the Modem Ready LED flashes. In all other ways, the fallback is transparent to the user.
- The modem does not send result codes reflecting the rate changes.
- Online fallback is distinct from the link negotiation fallback that makes the Courier HST compatible with most 300/1200/2400-bps modems.

Error Control Modes (&M*n*)

Under error control, the calling modem includes an error control request in its link negotiation signals. The answering modem may or may not recognize the request. The following options allow you to select a setting best suited to your default configuration as well as to individual calls.

&MØ

Normal Courier Mode, no error control. Use this setting if you're calling a non-MNP modem (2400/1200/300 bps), as the error control request may be misinterpreted by the

remote system and prevent a connection. Don't use this setting for 9600-bps calls.

&M1–3 These options are reserved for future use.

&M4 Normal/ARQ Mode. If the remote modem doesn't recognize the Courier's error-control request, the Courier automatically operates in Normal Mode (&M0). This setting is the default. Use this adaptive mode if error control isn't crucial.

&M5 ARQ Mode. If the remote modem doesn't recognize the error-control request, the Courier HST hangs up. Use this setting if error control is an absolute requirement.

With Auto Answer To use error control for incoming calls, set the modem for Auto Answer and for either &M4 or &M5. When calls come in, the Courier HST goes off hook and responds to an error-control request if one is sent. If the Courier doesn't receive a request and is set to Normal/ARQ Mode (&M4), it answers the call in Normal Mode. If it doesn't receive a request and is set to ARQ Mode (&M5), it hangs up.

Data Compression Mode (&K*n*) Data compression is implemented through Level 5 of the MNP protocol, and only occurs if the modems have established an ARQ connection. (Appendix A describes the ARQ-connection sequence at all MNP levels.) In addition to the obvious benefits to file transfer, compression speeds up interactive applications by filling the screen more quickly.

NOTE: The modem should also be set for Transmit Data flow control, preferably &H1.

&K0 Data compression disabled. Use this setting if you're transferring files that should not be compressed; see the throughput guidelines at the beginning of this chapter.

&K1 Auto enable/disable. Default. The Courier enables data compression only if the DTE rate setting (&B) is higher than the link rate (&N). If the rates are the same, the application of the compression algorithm may actually reduce throughput, to your disadvantage. If the remote modem doesn't recognize the request for compression, the ARQ connection proceeds at the last negotiated MNP level.

&K2 Data compression enabled. Use this setting if you don't want the modem to automatically disable compression. If the remote modem doesn't recognize the request for compression, the ARQ connection proceeds at the last negotiated MNP level.

FLOW CONTROL

Flow control is used to control data flow in both directions at the local DTE interface. For background information, refer to Appendix A.

Due to differing equipment requirements, the Courier's factory-set defaults disable flow control.

Transmit Data Flow Control (&H*n*)

This type of flow control is for data transmitted by the terminal to the modem. The modem monitors its buffer as data comes from the terminal. If the buffer approaches 90% capacity, the modem signals the terminal to stop sending. When the modem has sent enough data over the link to half empty the buffer, it signals the terminal to resume transmitting.

Transmit Data flow control should be enabled in the following situations:

- You're using error control (9600/2400/1200 bps).
- You're using data compression.
- The DTE rate is higher than the link rate, e.g., the terminal's sending at 19.2k bps and the link rate is 9600 bps.
- The volume of data transfer is high.

Transmit Buffer Sizes

The size of the modem's Transmit buffer depends on whether the connection is under error control or not, as follows:

ARQ connections: 3.5k bytes

Non-ARQ connections: 1.5k bytes, allowing error control file transfer protocols such as XMODEM and YMODEM to be used without flow control.

The non-ARQ buffer size can be reduced to 128 bytes to accomodate the operators of remote slower modems. See S-Register 15, bit 3, in Appendix B-5.

Hardware Control

The modem lowers the Clear to Send (CTS) signal on the RS-232C interface (Pin 5) when its buffer nears 90% capacity. The modem raises CTS when the buffer is about half full.

NOTE: If your terminal and communications software support CTS, use hardware control. It is more efficient and doesn't affect the data stream.

Warning

If you are using an XMODEM-type protocol to transfer binary files, always use hardware flow control. If your sys-

tem doesn't support CTS, *disable flow control* and be sure the terminal and link rates are equal by setting the modem to &B0 and &N0.

Software Control

The modem sends the conventional ASCII Transmit on/off (XON/XOFF) characters, depending on how full the buffer is, as follows:

XON	<Ctrl>-Q	(ASCII 17 Decimal, 11 Hex)
XOFF	<Ctrl>-S	(ASCII 19 Decimal, 13 Hex)

The ASCII characters may be user-defined; see S-registers S22 and S23 in Appendix B-5 and the ASCII chart in Appendix B-6 or on the Quick-Reference card.

&H0 Transmit Data flow control disabled. Default.

&H1 Hardware flow control. Recommended setting. Requires that your terminal and software support CTS. If your software requires, turn off XON/XOFF signaling.

&H2 Software flow control. Requires that your software support XON/XOFF signaling.

&H3 Use both hardware and software flow control. If you are unsure about what your equipment supports, select this option.

Received Data Flow Control

Separate commands, &R*n* (hardware) and &I*n* (software) control the flow of Received Data passed by the Courier to your DTE. If the data rate at the DTE interface is 9600 or 19.2k bps, there may be a need at times to signal the modem to temporarily stop passing data, for example, to read what's on the screen.

Hardware Control (&Rn)

If your terminal and software support Request to Send (RTS) on the RS-232C interface (Pin 4) and RTS is not always high, the terminal lowers RTS to signal the modem to stop passing it received data, and raises RTS when it is ready to receive.

&R0 Reserved.

&R1 Ignore RTS. Default. This setting is required if your terminal does not support RTS.

&R2 The modem only sends data to the terminal when RTS is high.

Software Control (&In)

Use of this command requires that your software support XON/XOFF signaling (Ctrl-Q and Ctrl-S, respectively).

NOTE: When software flow control is enabled, the modem looks for <Ctrl>-S or <Ctrl>-Q characters. If these characters occur in a file, they will be misinterpreted as flow control characters. We recommend that, if possible, you *select hardware flow control instead.*

&I0 Disable XON/XOFF flow control of received data. Default. Recommended for non-ARQ (Normal Mode) calls, but see &I5. This option makes all characters, including control characters, transparent to the modem.

&I1 The Courier acts on your typed XON/XOFF signals, and passes them to the remote computer. Use in ARQ Mode only, but keep in mind that the XON/XOFF signals sent to the remote computer may interfere with XON/XOFF signaling occurring at the remote computer/modem interface. See &I2.

&I2 The Courier acts on your XON/XOFF signals, but removes them from the data stream instead of passing them to the remote computer. This ensures that the remote computer does not confuse your XON/XOFF signals with those from its attached modem. This is the recommended setting for ARQ Mode.

However, if the call is not under error control, there is no flow control on the phone link. If you send an XOFF to your modem and it stops passing on data, there is no way to tell the remote computer and modem to stop sending, and your modem's buffer may overflow. For more reliable control in non-ARQ Mode, see &I5.

&I3 Hewlett Packard protocol—Host Mode. Applies only to modems attached to an HP mainframe. See Appendix E-5.

&I4 Hewlett Packard protocol—Terminal Mode. Applies only to modems attached to terminals in an HP system. See Appendix E- 5.

&I5 This setting is particularly designed to enable flow control on the phone link when the connection is not under error control.

At &I5, a Courier in ARQ Mode operates the same as it does when set to &I2. It acts on your XON/XOFF signals but doesn't pass them to the remote system. The error control protocol enables the modems to control the flow of data on the phone link.

In non-ARQ Mode, a Courier set to &I5 operates as though it were set to &I0, in respect to the local DTE interface. However, it also looks to the phone line for *incoming* XON/XOFF signals. When sent XON/XOFF signals from the *remote* operator, the Courier stops transmitting data over the link and drops the signals from the data stream.

If both modems are set to &I5, operators at each end can signal the remote modem to stop sending, thereby controlling the data flow on the phone link and preventing their own modem's buffer from overflowing. At the DTE/DCE interfaces, the modems independently control the flow of data through their Transmit Data (&H) settings.

DATA RATE COMMANDS

These commands allow you to select *variable* or *fixed* data rates at the DTE and link (modem-to-modem) interfaces. The highest possible rate at the DTE interface is 19.2k bps; the highest possible rate at the link interface is 9600 bps.

Variable Rates

At the modem's default settings (&BØ, &NØ) the rate at the DTE and link interfaces is the same, and varies with each call, as follows:

- Initially the modem detects its rate from the rate at which the terminal sends it the AT command. That rate is determined by the terminal or software setting.
- When originating or answering a call, the Courier and the remote modem negotiate the highest possible link rate. For example, if the terminal sends the AT command at 9600 bps and the Courier calls a modem operating at 1200 bps, the Courier automatically falls back to 1200 bps. The Courier notifies the terminal of the adjustment by sending the result code CONNECT 1200.

  The Courier readjusts to the rate of the next AT command or, if auto answering a call, readjusts to the rate of the remote modem. See Appendix E-2 for more details.

NOTE: If your software switches its rate to match the connection rate, reset the software for a higher speed call before

dialing again. For example, if your modem and software dropped back to a lower rate for the last call and you want to make a high-speed call, first reset the software. Otherwise your ATD (Dial) command is sent at the previous rate, and the remote 9600-bps modem drops back to match your lower rate.

Fixed Rates

If your software supports fixed rates, you can fix the rate at either the DTE or link interface, or both. These settings apply to both normal and error-control operations, but *be sure to enable Transmit Data (&H) flow control.*

Maximum Throughput Settings

For the greatest throughput, recommended settings (assuming software allows fixing the DTE rate) are as follows:

Terminal/software:	19.2k bps
Modem:	Fixed DTE rate (&B1)
	Variable link rate (&N0)
	Data compression (&K1)
	Transmit Data flow control (&H1, 2 or 3)

DTE Rate Select (&B*n*)

Use this command to select variable or fixed rates at the terminal interface.

&B0

Variable rates. Default. The terminal interface rate follows the connection rate. Requires &N0 for the link rate: the modem automatically adjusts to the rate of the remote modem.

&B1

Fixed rate: requires software support of this feature. Allowable terminal/software settings are 19200, 9600, 7200, 4800, 2400, 1200, 300 bps. Setting the terminal to 19.2k bps enables the greatest throughput.

Link Rate Select (&N*n*)

This command selects variable or fixed rates on the phone link.

&N0

Variable operations. Default. The link rate varies according to the modems' connection sequence.

&N1-6

Fixed link rate: the modem only connects if the remote modem is operating at the same rate. The setting may be lower than or equal to the &B setting. If lower than the &B setting, enable Transmit Data (&H) flow control to prevent the possibility of data loss. Allowable rates are as follows:

&N1	300 bps	&N4	4800 bps
&N2	1200 bps	&N5	7200 bps
&N3	2400 bps	&N6	9600 bps

If you wish, you can filter out calls at other than a specific speed, for security or other reasons, by fixing the link rate.

DSR OVERRIDE (&S*n*)

The Data Set Ready (DSR) function (Pin 6 on the RS-232C interface) is required on some systems to enable the modem to signal the terminal when the modem is ready to answer a call. Typically, DSR signaling is overridden.

&S0 DSR is always ON (overridden). This setting is the default.

&S1 The modem controls DSR.

The commands explained in this chapter are of two types. The first group concerns default configurations, for example, writing your own power-on defaults to nonvolatile random access memory (NRAM). The remaining commands are used to select the modem's local operating characteristics, for a current session or to include in your default configuration. They include result code, echoing, and other options.

NOTE: When you change a default setting during a session, the modem retains that setting until you do one of the following:

- Select a new setting.
- Issue the Z command to reload the NRAM defaults or the &F command to load the factory settings.
- Turn the modem off.

SETTING/USING DEFAULTS

The Courier HST is shipped from the factory with its software defaults stored in read only memory (ROM) and also in programmable nonvolatile random access memory (NRAM). The inclusion of NRAM allows you to program your own configuration and save the settings as your power-on defaults.

Writing Defaults to NRAM (&W)

If you store your own default software settings in NRAM, the Courier loads those settings when it is powered on if DIP switch 10 is UP (factory setting).

A list of the settings stored in NRAM is in Appendix B-4. You can also display the settings at any time by selecting option 5 of the I (inquiry) command:

```
ATI5 <cr>
```

If you've sent the modem commands to change settings throughout your session and want to save your current configuration, issue the &W command:

```
AT&W <cr>
```

You can also specify your configuration in a single command string that includes the &W command, as in this example:

```
AT X4 &B1 &M5 &H1 &I1 M3 &W <cr>
```

Modify one or several settings at any time, for example:

```
AT X7 &W <cr>
```

Loading the Factory Defaults (&F)

Factory defaults are permanently stored in read only memory (ROM). They are listed in the table of NRAM settings in Appendix B-4. You can set the modem to its factory defaults during any session by typing:

```
AT&F <cr>
```

If DIP switch 10 is DOWN, the factory settings are loaded at power on instead of the NRAM defaults.

Resetting to NRAM Defaults (Z)

To reset the modem to its NRAM defaults, type:

```
ATZ <cr>
```

NOTE: On reset, the modem also checks the status of the DIP switches: if you change the setting of switches 2–5 or 9 when the modem is on, use the Z command to initiate the new setting(s).

Storing Telephone Numbers (&Z*n*=*s*)

The modem stores up to four frequently called phone numbers. Write the numbers to NRAM with the &Z*n*=*s* command, where *n* is position Ø through 3, and *s* is the number-string.

The number-string may be up to 36 characters long, including any Dial command options. The following example includes the tone-dial (T) and comma pause options of the Dial command. The number is stored at position Ø, assumed because there is no *n* parameter.

```
AT&Z=T9,,5551234 <cr>
```

The next example stores the phone number and user's access code for a long distance phone service.

```
AT&Z1=5551234,,9876,, <cr>
```

Dial the stored number using the DS*n* command, for example, DS2 <cr>. Additional examples are in Chapter 6.

NOTE: Don't include modem settings in the &Z string. If the call requires a special setting, insert the appropriate command when you dial the stored number. In the following

example, &MØ (no error control) is substituted for the user's error control default setting:

```
AT&MØDS2 <cr>
```

Then reset the error control mode after the call, for example:

```
AT&M4 <cr>
```

RESULT CODES

Four commands control the result codes the modem returns to the screen:

V*n*	Numeric/verbal response mode
X*n*	Result code subset
Q*n*	Display/suppress all result codes
&A*n*	Display/suppress /ARQ result codes

Response Modes (V*n*)

Result codes are sent to the screen in either words (Verbal Mode) or numbers (Numeric Mode). The Courier is factory set to verbal messages when it is powered on (DIP switch 2 is UP). Use the V command to select verbal/numeric result codes independently of the power-on default.

VØ Numeric Mode. Numeric result codes are followed by a Carriage Return but no Line Feed, as in the following example, where a 3 is returned (for NO CARRIER).

```
ATD1234567 <cr>
```

becomes

```
3TD1234567 <cr>
```

V1 Verbal Mode. Verbal responses are preceded and followed by a Carriage Return and a Line Feed, as in the following example:

```
ATD1234567 <cr>
NO CARRIER
```

Result Code Sets

A table of result code options is on the next page. The format of the command to select a result code set is ATX*n*, where *n* is a value from Ø through 7:

XØ Basic subset, returns the first five codes (Ø–4) in the following table.

X1 Extended subset, codes Ø–5, 10 and 13. Default. This set adds rate-specific CONNECT messages to the Basic set.

X2-7 These options offer advanced call-progress codes and functions.

RESULT CODES OPTIONS TABLE								
	Commands							
	X0	X1	X2	X3	X4	X5	X6	X7
Result Codes								
0/OK	X	X	X	X	X	X	X	X
1/CONNECT	X	X	X	X	X	X	X	X
2/RING	X	X	X	X	X	X	X	X
3/NO CARRIER	X	X	X	X	X	X	X	X
4/ERROR	X	X	X	X	X	X	X	X
5/CONNECT 1200		X	X	X	X	X	X	X
6/NO DIAL TONE			X		X		X	X
7/BUSY				X	X	X	X	X
8/NO ANSWER				X	X	X	X	X
9/Reserved								
10/CONNECT 2400		X	X	X	X	X	X	X
11/RINGING						X	X	X
12/VOICE						X	X	
13/CONNECT 9600		X	X	X	X	X	X	X
Functions								
Adaptive Dialing			X	X	X	X	X	X
Wait for 2nd Dial Tone (W)				X	X	X	X	X
Wait for Answer (@)				X	X	X	X	X
Fast Dial			X		X		X	X

Options Summary

1. An additional group of CONNECT messages (15–17) indicates an error-control connection with an HST- or MNP-compatible modem. ➤ See the "/ARQ Result Codes (&A*n*)" later in this section.

2. Adaptive dialing causes the modem to automatically use Touch-Tone dialing and, if that doesn't work on the line, revert to pulse dialing.

3. W and @ are Dial options described in Chapter 6.

4. Fast dial causes the modem to dial as soon as a dial tone is detected, rather than wait the normal two seconds. If there is no dial tone, the modem times out after 5 seconds and sends the NO DIAL TONE (6) result.

5. After sending the BUSY (7) result code, the modem hangs up.

6. The NO ANSWER (8) result code is returned, instead of the standard NO CARRIER, when the @ option is used and there is no answer at the remote end.

7. After sending the VOICE (12) result code, indicating a voice answer, the modem hangs up.

8. X6 implements all result codes and functions. X7 includes all of X6 except the VOICE (12) result code.

Quiet Mode (Q*n*)

Enable/suppress the display of result codes. The Courier is shipped with DIP switch 3 DOWN and defaults to display ON when the modem is powered on. The commands here control the display independently of the power-on default.

Q0 Result codes are displayed.

Q1 Result codes are suppressed (made "quiet"). This is useful when the messages might interfere with the data stream.

/ARQ Result Codes (&A*n*)

If these codes are enabled, one of the following results is sent to the screen when a successful HST or MNP connection is established. (A setting of X1 or higher is assumed.)

(15) CONNECT 1200/ARQ
(16) CONNECT 2400/ARQ
(17) CONNECT 9600/ARQ

&A0 /ARQ codes are disabled. If your software does not allow the /ARQ result codes, use this setting. Suppression of the /ARQ codes doesn't affect the error control protocol; the modem returns the standard CONNECT messages.

&A1 /ARQ codes are displayed. This is the default.

LOCAL ECHO

Two commands control what the modem displays on the screen. The E*n* command applies to when the modem is in Command Mode. The F*n* command applies to when the modem is online to another system.

Command Mode Local Echo (E*n*)

The E*n* command enables/disables the display of your typed commands. If double characters appear on the screen, both the modem's local echo and the software's local echo are on. The Courier is shipped with DIP switch 4 UP, for local echo ON when the modem is powered on. The commands here control the echo independently of the power-on default.

E0 Command Mode echo OFF. The modem does not display keyboard commands.

E1 Command Mode echo ON.

Online Local Echo (F*n*)

This command causes the modem to display a copy of the data it is transmitting to another system. Many systems, however, return a copy of received data, which is called a remote echo. If the modem's online echo is ON and there is remote echoing, double characters appear on the screen.

In some microcomputer documentation the online echo setting is called the "Duplex" setting, although the term is not technically accurate.

F0 Online echo ON. Sometimes called Half Duplex. As the modem transmits data to a remote system, it also sends a copy of the data to the screen.

F1 Online echo OFF. Sometimes called Full Duplex. This is the default.

THE AUDIO MONITOR

The modem's speaker enables you to monitor the dial-connect process. There are several ways to make use of this feature. After the Courier HST dials a number, it waits 30 seconds for a high-pitched answer tone from the other modem, immediately followed by data signals, called a *carrier*. These signals must occur before a data link is established.

If someone answers the phone, or if the line is busy, the modem sends the message NO CARRIER to your screen after 30 seconds. If you listen to the speaker, you can respond immediately instead of waiting for the modem to time out.

For example, if you hear someone answering the call, you might pick up the phone and talk to the person or cancel the call by pressing any key on the keyboard. In the same way, you can cancel a call when you hear a busy signal.

You can also hear if dialing is proceeding too fast for the system. Terminate the call (press any key) and reenter the Dial command with a comma or two to allow more time. This applies to accessing an outside line (dialing 9, for example) as well as to checking out whether a public service has enough time to respond to your account number or other code.

Speaker Control (M*n*)

You can disable the speaker entirely or set the speaker to monitor different segments of the dial-connect sequence.

M0 The command ATM0 turns the speaker OFF entirely so that you don't hear the modem go off hook, dial, etc.

M1 The speaker is ON until Carrier Detect. Default. You can monitor call progress until the Courier detects the remote modem's carrier signals, or until the 30-second timeout and result code display. At Carrier Detect, the modem disconnects the speaker and data transmission sounds are suppressed.

M2 The speaker is ON continuously, including during data transmission.

M3 The speaker doesn't go ON until after the last digit is dialed, then goes OFF at Carrier Detect.

MODEM CLOCK USAGE (K*n*)

The modem clock is used as a call-duration timer or as a real-time clock. Used in conjunction with the I*n* (Inquiry) command, the modem returns the duration of the last call in hours, minutes, and seconds or the actual time.

K0 Call-Duration Mode. Default. The modem times each call from CONNECT to NO CARRIER, and stores the information until the next connection or the modem is reset. At ATI3 <cr>, the modem displays the call's duration. If you wish, you can maintain a call log by printing this information after each call.

K1 Real-Time Mode. The clock operates as a real-time clock regardless of the presence of a carrier. Set the clock (military time) by specifying the hour, minutes, and seconds as in the following example, which sets the clock at the real time of 1:30 p.m.

```
ATI3=13:30:00 K1 <cr>
```

At ATI3, the modem displays the real time. You'll need to set the clock each time you power on the modem, but the clock is not affected by the reset command, ATZ.

TRANSMITTER ENABLE/ DISABLE (C*n*)

If an additional terminal and modem share the phone line for monitoring purposes, the second modem is placed in Receive Only state by disabling its transmitter.

C0 Transmitter disabled. Modem is set to Receive Only.

C1 Transmitter enabled. Default.

BREAK HANDLING (&Y*n*)

The Courier HST allows you to send a break to abort data transfer without disconnecting from the data link. The following options are available.

NOTE: A destructive Break to the modem resets its data compression tables. The remote modem also resets its compression tables.

&Y0 Destructive, no Break transmitted: the modem clears the data from its transmit buffer (all data is lost) but does not pass on the Break to the remote modem.

&Y1 Destructive, expedited: the modem clears the buffer and immediately sends a Break to the remote modem. This is the default setting.

&Y2 Nondestructive, expedited: the modem retains buffer data, but immediately sends a Break to the remote modem.

&Y3 Nondestructive, unexpedited (send Break in sequence): the modem transmits any buffer data received before the Break, sends the Break, and then sends any subsequent input from the computer or terminal.

THE S-REGISTERS

The S-Registers are used to set various timing parameters and other operations, including redefinition of selected ASCII characters. The defaults typify the requirements of most users.

➤ A detailed summary of the S-Register functions is in Appendix B-5. Less detailed summaries are on the bottom label of the modem case and in the Quick-Reference card.

CHAPTER 6
DIALING AND ANSWERING

BASIC REQUIREMENTS

To successfully establish a communications link, the called or calling modem must be compatible with the following standards at the specified rates.

Bits per Second	Standard
9600	USR-HST or compatible
2400	CCITT V.22*bis*
1200	Bell 212A
300	Bell 103

To successfully exchange data, both modems must use the same 10-bit data format. The formats allowed are as follows:

Start Bits	Data Bits	Parity	Stop Bits
1	7	Even, Odd, Mark, Space	1
1	7	None, Even, Odd, Mark, Space	2
1	8	None	1,2

Transmission Rate

In general, you should know the transmission rate of the other modem before calling. However, if the link rate is set to the default, &NØ, and the Courier HST tries to connect with a modem operating at a lower rate, the Courier falls back to the rate of the remote modem. This applies to both Originate and Answer Modes. ➤ See the discussion under "Data Rate Commands," in Chapter 4.

Error Control

Always set the Courier HST for error control, &M4 (the default) or &M5, for 9600 bps connections.

It's a good idea to find out if the remote modem is MNP-compatible at 2400/1200 bps. Some public network services, for example, are not. When the Courier HST is set to &M4 it includes an error-control link request in its handshake signals. If the remote modem isn't under error control, the Courier operates in Normal Mode (no error control). However, if the remote modem doesn't support the MNP protocol at 2400 or 1200 bps, the MNP link-request signals may

be misinterpreted and block a successful connection. If you know the remote modem doesn't support MNP, we recommend setting the Courier HST to &MØ before dialing.

Automatic Retrain

An HST or V.22*bis* modem sends a retrain signal if it senses that a problem in the phone line connection may be causing data unreliability. The modems stop the transfer of data for about a second while they resynchronize, and then resume Data Mode operation.

Retraining only occurs during 9600 and 2400 bps communications. ➤ For a description of the signaling sequence, see Appendix E-3.

PLACING CALLS

The commands discussed in this section are used in the following operations:

Dialing	D (0-9 # * , ; ! P T W @ R), DS*n*
Redialing	A/, A>, >
Canceling dialing	<any key>

Dial (D)

When the Dial command is issued the modem goes off hook—the equivalent of your picking up the phone—then enters Originate Mode and dials the number sequence that follows. The modem also executes any other commands or options included in the command line.

The command string may include up to 40 characters, plus the AT prefix and Carriage Return/Enter key. The modem doesn't count spaces. It counts punctuation characters such as parentheses and hyphens, but ignores them.

The following command instructs the modem to stop the display of commands (EØ, turn off the local echo), to dial (D) using Touch-Tone dialing (T), and to turn off the speaker (MØ). The spaces shown are ignored by the modem and are only included here for readability.

```
AT EØ DT 1234567 MØ <cr>
```

Dialing Type, XØ or X1 Setting

If set to XØ or X1, the modem defaults to pulse (rotary) dialing. To have the modem use tone dialing, use the T command, which also allows you to use the asterisk (*) and pound sign (#). The command may be included in the Dial string, as in the above example, or issued separately:

```
ATT <cr>
```

The following command resets the modem to pulse dialing:

ATP <cr>

You can switch from one dial type to another within a dialing sequence. For example, you might have a phone line that only accepts pulse dialing (slower than Touch-Tone dialing) but subscribe to a long-distance service that accepts tone dialing, such as MCI. You can switch to tone dialing once you've hooked into the long-distance service. In the following example, a switch is made to tone dialing before entering a service account number and the long-distance destination. (The commas are discussed shortly.)

ATDP 9,,7654321,,T 55555,,1 312 1234567 <cr>

NOTE: The modem remains set for Touch-Tone dialing until it is reset or the ATP (pulse) command is reissued.

Adaptive Dialing, X2–X7 Settings

When any of the X2 through X7 options is in effect and you don't issue a dialing type in the Dial string, the Courier uses tone dialing, which is faster than the default pulse type. However, if the phone company central office doesn't have Touch-Tone detection equipment, the modem can not "break dial" and continues to detect the dial tone. If this occurs, the modem automatically reverts to pulse dialing.

Pause (,)

A comma causes a two-second delay in the dial sequence. The following example contains four-second delays at several points:

ATDP 9,,7654321,,T 55555,,1 312 1234567 <cr>

The first four-second pause is to access an outside line after dialing 9, the second to make sure the remote computer is ready for the user's account number, and the third, to delay before dialing the long-distance number.

Such pauses, however, may not be necessary. Experiment and use delays only as required.

NOTE: A slash (/) can be used in any command string to have the modem pause for only 125 milliseconds. Some users find the shorter delay of a series of slashes, rather than the 2-second comma pause, useful for certain applications.

Dial and Return to Command Mode (;)

If your phone is plugged into the modem, you can use this option to have the modem Auto Dial a telephone rather than a modem. The Courier dials, remains off hook and returns the OK message, indicating it is in Command Mode.

For example, if your phone is plugged into the modem you can have the modem place a voice call. Issue the Dial command with a semicolon:

```
ATDT5551234; <cr>
```

When the modem returns the OK result, pick up your phone receiver so you can talk to the other party and tell the modem to hang up:

```
ATH <cr>
```

Similarly, you can call a recorded weather or other service. Have the modem Dial, listen to the recording over the modem's speaker and, when you're finished, tell the modem to hang up.

Another example is an information or other service that requires a Touch-Tone entry of an ID as part of the log-on procedures. The following sequence is an example.

```
ATDT1234567; <cr>     (dial the service's telephone
                       number and return to Com-
                       mand Mode)
OK
ATDT65432; <cr>       (dial ID and return to Com-
                       mand Mode)
OK
.
.
.
ATH <cr>              (session is finished;
                       hang up)
OK
```

Dialing Letters (")

Quotation marks are used to have the modem dial abbreviations and acronyms used as phone "numbers," such as DIAL USR (the USRobotics Sales Department's 800 number). The option is called Quote Mode. Quotation marks are inserted at the beginning of the alphabetic string:

ATDT"BBS-NEWS <cr>

If you're including another command after the dial string, use closing quotation marks before the additional command.

Transferring Calls (!)

This command applies to modems in installations where other modems share the phone line. The modem flashes the switch-hook, i.e., goes off hook 0.5 seconds, on hook for 0.5 seconds, and off hook again to dial the specified extension. The following example includes instructions to return to Command Mode (;) and to hang up (H).

ATDT !1234;H <cr>

Wait for a Second Dial Tone (W)

This command is useful in situations where you must wait for a second dial tone before entering a password, for example, when using MCI, Sprint, or other long-distance service. The following command tells the modem to dial the service number, wait for the second dial tone, dial the ID, pause two seconds, then place the long-distance call.

ATDT 5551234 W 12345, 3121234567 <cr>

NOTE: This command executes only if result code option X3 or greater has been issued. If the modem is set to X2 or lower, the modem interprets the W as a comma (two-second pause).

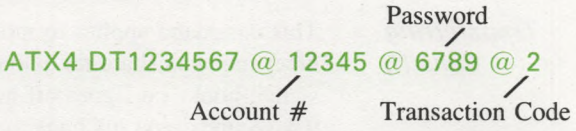
Wait for an Answer (@)

Some online services answer the phone and return a tape-recorded request for information before processing transactions. In such instances, the @ command can be used in the Dial string to tell the modem to detect at least one ring, wait for five seconds of silence at the other end of the call, and then continue to execute the Dial string.

To use the @ command, set the modem to X3, X4 or X7. If the modem is set to X2 or lower, the modem returns an ERROR message when encountering the @ character in a command string. If set to X5 or X6, the modem hangs

up when it detects a voice answer and sends the VOICE result code.

In the next example, the modem is set to the X4 result code option and dials a banking service. Each occurrence of @ in the example indicates a five-second wait for silence after taped requests from the bank for the labeled items. The transaction code might be used, for example, to request an account balance.



If the necessary conditions don't occur—no rings, or no following five seconds of silence—the modem times out as it normally would (after 30 seconds). It then sends the message NO ANSWER to the screen and aborts the command.

Reversing Originate/Answer Frequencies (R)

This command allows calls to an originate-only modem. It reverses the modem's originate/answer frequencies, forcing the Courier to dial out at the answer frequency. The command follows the Dial command, before or after the phone number:

```
AT D1234567R <cr>
AT DR1234567 <cr>
```

CANCELING DIALING

To cancel dial-command execution, press <any key>. If you inadvertently hit a key on the keyboard while the modem is dialing, the call is canceled. If this occurs, type the A/ command explained in the next section.

REDIALING

The most frequent reason for redialing is receipt of a busy signal. The Courier HST provides three ways to redial, as follows.

Re-execute the Last Command (A/)

The A/ command, which doesn't take the AT prefix or a Carriage Return, redials one time:

```
A/
```

When the modem receives a command, it stores the instruction in its command buffer until the next AT command is received. Note that if you've sent the modem an additional command since the Dial command, A/ re-executes that command instead of redialing.

Automated Redialing (>, A>)

These two commands, while they can be used to continuously repeat any command, are designed for automated redialing. The first (>) is included in the Dial command. The second (A>) is used alone to redial the command string in the buffer.

Continuous Repeat (>)

If you know the modem you're calling is frequently busy, include the Repeat command in the Dial string, as in either of the following examples:

```
AT > DT 1234567 <cr>
AT DT 1234567 > <cr>
```

The modem enters Repeat Mode, dials the number, waits the default 30 seconds for a carrier, and hangs up. Then, after a two-second pause, it redials.

The cycle continues until the modems connect or the modem reaches a maximum of 10 attempts. The 10-try limit is mandated by the Canadian Department of Communications (DOC) to prevent tying up local telephone company exchanges with unconnected calls.

Continuous Re-execute (A>)

This command combines the features of both the A/ and > commands. The modem enters Repeat Mode as described above, and continuously redials the Dial string in the command buffer. Like the A/ command, A> doesn't take the AT prefix or a Carriage Return:

```
A>
```

Exiting Repeat Mode

Should you use > or A> with a command other than a Dial string, abort the cycle by pressing <any key>.

To abort automated redialing, be sure to press <any key> when the result code appears, during the pause before the modem begins dialing again. If you press <any key> while the modem is dialing, that dial attempt is canceled but the cycle continues.

DIALING A STORED NUMBER (DS*n*)

Chapter 5 includes instructions for storing up to four telephone numbers in nonvolatile random access memory (NRAM). To have the modem dial a stored number use the DS*n* command, where *n* is the number's position, Ø–3, in NRAM. In the first of the next two examples, the phone number is stored at position Ø, assumed by the modem if there is no numeric parameter:

```
ATDS <cr>
ATDS3 <cr>
```

If you've stored a long distance service number/access code, for example at position 1, use the DS*n* command to dial the number and code, and follow that with a Dial command to dial the call's destination. (The spaces are included for readability.)

AT DS1 D 312 5556789 <cr>

ESCAPE CODE OPERATIONS (+++)

Once the modem is online to another system, the only command it recognizes is an escape code of three pluses, which forces the modem back to Command Mode:

—Wait one second after entering the last item of data
—Type: + + +
—Wait one second before typing any data

Do not type the AT prefix or a Carriage Return. The guard time of one second before and after the code prevents the modem from misinterpreting the occurrence of + + + in the transmitted data stream.

If necessary, the character used in the escape code can be changed by resetting S-register 2. ➤ See Appendix B-5.

Modem Response to +++

The modem returns to Command Mode when it detects the escape code. However, it keeps the line open or hangs up, depending on the setting of DIP switch 9:

DIP Switch 9	Response to + + +
DOWN	Modem maintains connection, sends OK result code (factory setting)
UP	Modem goes on hook (hangs up), sends NO CARRIER result code

Retain the factory setting if you want the modem to execute commands and return online. (See the O command, below.)

If you want an automatic disconnect when you issue + + +, set switch 9 UP. (If the modem is on, also issue the ATZ command.) An advantage of this is that you're not likely to inadvertently run up an all-night phone bill.

WARNING

For unattended modem operations: in rare instances, the modem may fail to recognize the + + + escape code sequence. If you are running the modem under software

control for unattended operations, we suggest you use the surefire method of *dropping the RS-232C DTR signal for at least 50 milliseconds,* to ensure against costly phone charges. Methods of turning the DTR signal off, e.g., closing the communications port, differ from one computer to another.

RETURNING ONLINE (O)

If DIP switch 9 is DOWN (on detection of the escape code the modem maintains the connection), you can issue commands and then toggle the modem back online with the O command:

```
AT Q1 O <cr>
```

HANGING UP (H*n*)

If DIP switch 9 is DOWN (factory setting), the escape code forces the modem back to Command Mode but leaves the line open. To instruct the modem to hang up, issue the following command once the modem sends the OK result code:

```
ATH <cr>
```

If DIP switch 9 is UP, the modem automatically hangs up on receipt of the escape code.

AUTOMATIC ANSWERING

The Courier HST is shipped with DIP switch 5 DOWN, Auto Answer suppressed. To set the modem to automatically answer incoming calls, do one of the following:

1. Before powering on the modem, set DIP switch 5 UP. When you turn the modem on, it answers incoming calls on the first ring.

2. If the modem is on, use software control. The following command instructs the modem to answer on the first ring. (You can substitute a higher value. See the S-Register summary in Appendix B-5.)

```
ATS0=1 <cr>
```

When the modem senses a call coming in, it sends the result code RING to your screen, goes off hook, and sends the remote modem a high-pitched answer tone. If there is no Carrier Detect within 30 seconds, the modem hangs up. If the connection is made, the modem sends a CONNECT result code. When the call is disconnected by you or the remote user, the modem hangs up and returns the NO CARRIER code.

Suppressing Auto Answer

To disable Auto Answer, reverse steps 1 or 2 above. Set DIP switch 5 DOWN before powering on the modem or, if it is powered on, use the command to set the modem to answer on zero rings:

ATS0=0 <cr>

Points to Remember

1. If the modem is attached to a computer, you can set the modem to receive calls when you're not there. Put the modem in Terminal Mode and set it for Auto Answer. Also set your software's file-save function to save incoming messages and/or files.

2. If you've attached your phone so it can be used for conventional calls, disable Auto Answer when you're not expecting incoming calls. Otherwise, your modem may answer the phone before you do, greeting your caller with a high-pitched, irritating answer tone.

INTERNATIONAL CALLS

The Courier HST has three settings which enable international calls. These settings do not apply to calls originating in the U.S. or Canada.

U.S./CCITT Answer Tone (B*n*)

In the United States and Canada, modems use a 2225 Hz answer tone. Outside North America, most modems adhere to the CCITT V.25 standard and send out a 2100 Hz tone followed by a 2250 Hz tone. If you're expecting an overseas call, set the Courier to use the CCITT answer tone. The setting won't affect the modem's ability to connect with a domestic modem although it will take slightly longer to connect with a calling modem.

B0 CCITT answer sequence, used to answer calls originating outside North America. Required setting for &G2, below.

B1 U.S. answer sequence. Default.

Guard Tone (&G*n*)

British phone switching systems require the modem to send an 1800 Hz guard tone after sending an answer tone. The guard tone is not used in the U.S. or Canada.

&G0 No guard tone, U.S. and Canada. Default.

&G1 Reserved.

&G2 1800 Hz guard tone follows answer tone, United Kingdom and some Commonwealth Countries. Requires B0 setting as well.

Pulse Dial Make/ Break Ratio (&P*n*)

This command sets the ratio of the off-hook/on-hook (make/ break) interval for pulse dialing. The default sets the modem for use in North America. The ratio must be changed if the modem is used in the United Kingdom and some Commonwealth countries.

&P0 Make/break ratio, U.S./Canada: 39%/61%. Default.

&P1 Make/break ratio, United Kingdom, some Commonwealth countries: 33%/67%.

CHAPTER 7
QUERIES AND HELP SCREENS

USER INQUIRIES (I*n*)

The Inquiry command has eight options. The most commonly used options display the following information:

ATI3	Call duration
ATI4	Current settings
ATI5	NRAM settings
ATI6	Link diagnostics summary

I0 The modem returns a 3-digit product code. If you have a problem and call USRobotics' Technical Support Department, you may be asked for this product code.

I1 The modem performs a checksum of its read only memory (ROM) and returns the result to the screen. This function is used only in factory testing. The modem should always read the same number.

I2 The modem performs a test of its random access memory (RAM) and returns either the OK (0) or ERROR (4) result code, followed by OK when the test is completed. You may want to use this command as a checkpoint if the modem appears to be malfunctioning.

I3 The modem returns the duration of the last call if set to K0. It displays the actual time if set to K1. See the description of the K*n* command in Chapter 5.

I4 The modem displays its current configuration. The illustration on the following page is an example.

```
USRobotics Courier 9600 HST Settings....

   C=1  E=1  F=1  M=1  Q=0  V=1  X=1  B=1
   BAUD=19200  PARITY=N  WORDLEN=8
   DIAL=PULSE  ON HOOK    TIMER

   &A1  &B0  &G0  &H0  &I0  &K1
   &M4  &N0  &P0  &R1  &S0  &Y1

   S00=001  S01=000  S02=043  S03=013
   S04=010  S05=008  S06=002  S07=030
   S08=002  S09=006  S10=007  S11=070
   S12=050  S13=000  S14=000  S15=000
   S16=000  S17=000  S18=000  S19=000
   S20=000  S21=010  S22=017  S23=019
```

Figure 7.1—Sample Result of ATI4 Command

I5 The modem displays the configuration stored in nonvolatile random access memory (NRAM).

```
USRobotics Courier 9600 HST NRAM Settings....

   DIAL=TONE   M=1  X=7  F=1  B=1
   BAUD=19200  PARITY=N  WORDLEN=8

   &A1  &B1  &G0  &H1  &I0  &K1
   &M4  &N0  &P0  &R2  &S0  &Y1

   S02=043  S03=013  S04=010  S05=008
   S06=002  S07=045  S08=002  S09=006
   S10=007  S11=055  S12=050  S13=000
   S15=000  S19=000  S21=010  S22=017
   S23=019

   STORED PHONE #0:
              #1: 1-312-9825092
              #2:
              #3:
```

Figure 7.2—Sample NRAM Settings Screen (ATI5)

I6 During a connection, the modem monitors and stores information about link operations. When the call is ended, you can request a diagnostic summary, as in the following example.

```
Chars sent                3        Chars received          1288
Chars lost                0
Octets sent               3        Octets received          691
Blocks sent               2        Blocks received          123
Blocks resent             0

Retrains Requested        0        Retrains Granted           0
Line Reversals            0        Blers                      0
Link Timeouts             0        Link Naks                  0

Data Compression      On
Equalization          Long
Fallback              Enabled
Speed                 9600/450

Disconnect Reason is User Hung Up
```

Figure 7.3—Sample Link Diagnostics Screen (ATI6)

Explanation of Terms

Octets	Compressed characters
Blers	Errors in protocol (non-data) blocks
Link Naks	Negative acknowledgments (one or more blocks)
Link Timeouts	Protocol operations, not the retry timeout; used in internal testing
Data Compression	On/Off: indicates if data compression was negotiated for the call
Equalization	Long/Short: status of S15 bit 0; long if bit 0 = 0, short if bit 0 = 1
Fallback	Enabled/Disabled: indicates whether or not the modems negotiated online fallback during the connection sequence

I7 The modem returns a product configuration. If you have a problem and call USRobotics' Technical Support, you may be asked to display this screen.

S-REGISTER QUERY (S*r*?)

This command allows you to view the contents of a particular S-Register, as in this example which requests the contents of register S0 (''On what ring will the modem answer?''):

ATS0? <cr>

Most registers store values that can be user-defined. However, two registers that are not user-programmable can be queried for the following diagnostic information.

S17 The reason for a Link Disconnect when two modems try to make an ARQ connection and fail, or when the remote modem disconnects from an ARQ session. S17 is used for debugging purposes. If you're having an ARQ-compatibility problem and call USRobotics' Technical Support Department, you may be asked to check S17.

S20 The reason for a NO CARRIER result code when the modem is in either ARQ or Normal Mode. Reasons include user aborts (pressing <any key> during dialing), loss of carrier, and the automatic hangup that occurs when the modem is set to &M5 and calls a modem not operating under error control.

PHONE NUMBER QUERY (&Z*n*?) At this command, the modem returns the phone number stored in NRAM at position *n*, as in the following example that includes a sample modem response:

```
AT&Z3? <cr>
5551234
```

HELP SCREENS The Courier HST provides four Help screens: summaries of the basic AT command set, extended ampersand (&) command set, S-register functions, and Dial command options.

Stop/Restart Display The following command stops the display. Hold down the Control key and type "S":

```
<Ctrl>-S
```

To restart the display, use the same command or press <any key>.

Cancel Display Either of the following commands cancels the display.

```
<Ctrl>-C
<Ctrl>-K
```

Basic Command Set ($) At AT$, the Courier displays the following command set summary:

```
HELP,  Command Quick Reference (CTRL-S to Stop, CTRL-C to Cancel)

A$    HELP, Extended Commands          In    n=5  NRAM Settings
A     Answer Call                              n=6  Link Diagnostics
A/    Repeat Last Command              Kn    n=0  Call Duration Mode
Bn    n=0  CCITT Answer Sequence               n=1  Real Time Clock Mode
      n=1  Bell Answer Sequence        Mn    n=0  Speaker Off
Cn    n=0  Transmitter Off                     n=1  Speaker On Until CD
      n=1  Transmitter On                      n=2  Speaker Always On
Dn    Dial a Telephone Number                  n=3  Speaker Off During Dial
      n=0..9#*TPR,;"W@!()-             O     Return On-Line
DSn   Dial Stored Phone Number         Qn    n=0  Result Codes Sent
D$    HELP, Dial Commands                      n=1  Quiet (No Result Codes)
En    n=0  No Command echo             Sr=n  Sets Register "r" to "n"
      n=1  Echo Command Chars          Sr?   Query Register "r"
Fn    n=0  Online echo                 S$    HELP, S Registers
      n=1  No Online echo              Vn    n=0  Numeric Responses
Hn    n=0  On Hook (Hang Up)                   n=1  Verbal Responses
      n=1  Off Hook                    Xn    n=0  Basic Result Codes
In    n=0  Product Code                        n=1  Extended Result Codes
      n=1  Checksum                            n=2-7  Advanced Result Codes
      n=2  RAM Test                    Z     Software Reset
      n=3  Call Duration/Clock         )     Repeat Command String
      n=4  Current Settings            $     HELP,  Command Summary
```

Figure 7.4—Basic Commands HELP Screen

Extended Command Set (&$)

At AT&$, the Courier displays this summary of the ampersand command set. TX and RX are shorthand for Transmit data and Receive data.

```
HELP, Extended Commands (CTRL-S to Stop, CTRL-C to Cancel)

&An   n=0  Disable /ARQ  Result Codes    &Mn   n=0  Normal Mode
      n=1  Allow /ARQ  Result Codes             n=4  ARQ/Normal Mode
&Bn   n=0  Variable DTE Speed                   n=5  ARQ Mode
      n=1  Fixed DTE Speed               &Nn   n=0  Highest Link Speed
&F    Load Factory Configuration                n=1  300 bps      n=3  2400 bps
&Hn   n=0  Disable TX data flow control         n=2  1200 bps     n=6  9600 bps
      n=1  CTS                           &Pn   n=0  N. American Pulse Dial
      n=2  Xon/Xoff                             n=1  UK Pulse Dial
      n=3  CTS and Xon/Xoff              &Rn   n=1  Ignore RTS
&In   n=0  Disable RX data flow control         n=2  RX Data to DTE / RTS high
      n=1  Xon/Xoff                      &Sn   n=0  DSR always On
      n=2  Xon/Xoff chars filtered              n=1  Modem controls DSR
      n=3  HP Enq/Ack Host Mode          &W    Store Current Configuration
      n=4  HP Enq/Ack Terminal Mode      &Yn   Break options
&Kn   n=0  Data Compression Disabled     &Zn=s Store Phone Number
      n=1  Auto Enable/Disable           &Zn?  Query Phone Number
      n=2  Enabled
```

Figure 7.5—Ampersand Commands HELP Screen

S-Register Functions (S$)

At ATS$, the Courier displays a summary of the S-register functions:

```
HELP, S Register Functions (CTRL-S to Stop, CTRL-C to Cancel)

S0  Ring to Answer On                S11 Touch Tone Spacing (msec)
S1  Counts # of Rings                S12 Escape Code Time (1/50sec)
S2  Escape Code Char                 S13 Bit Mapped
S3  Carriage Return Char             S15 Bit Mapped
S4  Line Feed Char                   S16 Test Modes
S5  Backspace Char                   S17 LD Reason
S6  Wait Time/Dial Tone (sec)        S19 Inactivity Timeout (min)
S7  Wait Time/Carrier (sec)          S20 Disconnect Reason
S8  Comma and Repeat Pause (sec)     S21 Break Length
S9  Carrier Detect Time (1/10sec)    S22 Xon Char
S10 Carrier Loss Time (1/10sec)      S23 Xoff Char
```

Figure 7.6—S-Register HELP Screen

Dialing (D$)

At ATD$, the Courier displays this Dial command summary:

```
HELP, Dial Commands (CTRL-S to Stop, CTRL-C to Cancel)

0-9 Digits to Dial
*#  Auxiliary Digits
T   Tone Dialing
P   Pulse Dialing
R   Call an Originate Only Modem
,   Pause
;   Remain in Command Mode
"   Used to Dial Alpha Phone #'s
W   Wait for 2nd Dial Tone (X3-X7)
@   Wait for an Answer (X3-X7)
!   Flash Switch Hook
```

Figure 7.7—Dial Command HELP Screen

PART II. REFERENCE

APPENDIX A—Error/Flow Control Concepts A-1

MNP Level Negotiation A-1
Throughput A-1
Level 1 A-1
Level 2 A-2
Level 3 A-2
Level 4 A-2
Level 5 A-3
Error Detection/Retransmission A-3
Flow Control A-4
Example 1—Transmit Data A-5
Example 2—Received Data A-5

APPENDIX B—Summaries and Tables B-1

The RS-232C Interface, with Pin Definitions B-1.1
Front End Indicators B-2.1
DIP Switch Summary B-3.1
Default Settings B-4.1
S-Register Summary B-5.1
ASCII Chart B-6.1

APPENDIX C—Alphabetical Command Summary C-1

APPENDIX D—Problems and Solutions D-1

If You Still Have Problems D-3

APPENDIX E—Additional Operational Information E-1

Using Both Voice and Data Communications E-1.1
High Speed/Low Speed Protocol E-2.1
Retrain Sequence E-3.1
PBX, Dedicated Line, and Leased Line Operations E-4.1
Hewlett Packard Installations E-5.1
Analog Loopback and Other Tests E-6.1

APPENDIX F—Technical Specifications F-1

GLOSSARY G-1

INDEX

At 2400 and 1200 bps, the Courier HST uses the MNP error control protocol, Service Levels 1-5. MNP was originally developed by Microcom, Inc. and is now in the public domain. At 9600, 7200 and 4800 bps the modem uses similar, compatible error control procedures developed by USRobotics.

In USRobotics implementations, we use the general term ARQ (automatic repeat request) to denote a connection under error control. Error-free data transmission is ensured through two features:

- error-detection and retransmission techniques;
- data buffering and flow control.

NOTE: As with all protocols, error control only works when the Courier HST connects with another modem that implements the same protocol.

MNP LEVEL NEGOTIATION

When the modems negotiate an ARQ connection, they indicate their highest of the first three Service Levels, 3, 2, or 1, and agree to operate at the highest possible level. The Courier HST indicates Level 3 in its MNP error-control parameter. If necessary, the Courier drops back to meet the requirements of the other modem. This establishes the error-control (ARQ) connection.

Levels 4 and 5, which enhance throughput performance, are only possible if the ARQ connection is also established. The Courier negotiates for a Level 4 connection, with the longer, streamlined transmission frames described on the next page. Whether or not Level 4 is agreed upon, the Courier also negotiates for a Level 5 connection (data compression). It's possible for an ARQ connection to be at Level 1, 2 or 3, with or without Level 4 and/or Level 5.

Throughput

Chapters 3 and 4 include recommended modem settings and file-transfer guidelines for gaining maximum throughput. The following descriptions of MNP Levels 1-5 include achievable throughput statistics.

Level 1

This level, often called Block Mode, supports half-duplex (one way at a time) transmission. The sending modem transmits a block of data and waits for an acknowledgment from the receiving modem before sending the next.

Level 1 is the slowest and is included because some computer equipment is restricted to either sending or receiving at any one time. This mode of operation is usually observed in communications between terminals rather than in terminal-to-computer or computer-to-computer links.

Level 2 This class, often called Stream Mode, supports full-duplex transmission in which data flows in both directions at the same time. Throughput at Level 2, due to protocol overhead, achieves about 84% of the throughput of a normal modem, or approximately 202 characters per second (cps) at 2400 bps.

Level 3 Level 3 incorporates Level 2 and is more efficient. Modems sending at Level 3 strip the Start and Stop bits from the data characters and transmit the data across the link in bit format, as in synchronous transmission, rather than in character format. The receiving modem reinserts the Start and Stop bits for each character before passing the data to the receiving computer or terminal.

This procedure offsets the protocol overhead loss so that throughput is about 108% that of a normal modem. Under optimal conditions, two Level 3 modems operating at 2400 bps can exchange data at approximately 254 characters per second.

Level 4 At this level, the information in the headers of transmission frames is streamlined to eliminate some of the protocol overhead. In addition, the size of the frames is greater than with Level 3.

The results in characters per second (cps) are as follows. These reflect operations without the data compression available with MNP Level 5.

	Characters per Second	
Link Rate	Level 3	Level 4
9600	1100	1160
2400	254	276

In general, with Level 4 you can expect a throughput gain of 5%, although actual throughput depends on the type of call. Gains on long-link satellite calls can range from 25-50%.

Level 5

Under data compression, the sending modem detects redundant units of data and recodes them into shorter units of fewer bits. Examples include the frequent occurrences of spaces, control characters, or the characters *e* and *s* in ASCII text files. The receiving modem decompresses the redundant data units before passing them to the receiving computer/terminal.

With data compression, throughput of up to 19.2k bps is possible. Achievable throughput rates for different kinds of files, in characters per second (cps), are shown in the following table.

The table assumes the following optimal conditions:

- DTE rate set at 19.2k bps; modem set to &B1 and &N0
- Connection (link) rate of 9600 bps
- Level 4 also enabled (longer transmission frames)
- Straight data (e.g., not already compressed, no file-transfer protocol)
- Transmission from a fast (e.g., 286) computer

File Type	Throughput (cps)
Assembler or Compiler Listing	1920
Text file	1550-1750
Binary file: .EXE	1450-1600
Binary file: .COM	1400-1500
.ARC files (common on BBS's)	1000-1100*
Random binary 8-bit	975-1050*

*As mentioned on Page 4-2, these files are already compressed or appear to the modem to be compressed. If they undergo additional data compression, they become longer.

ERROR DETECTION/ RETRANS-MISSION

During an ARQ connection the transmitting modem divides the data it receives from the computer or terminal into blocks, and attaches header and trailer information. The result is called a *frame*, as shown in Figure A.1.

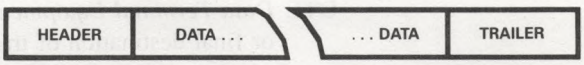


Figure A.1—Transmission Frame

Included in the header or trailer are a frame number and block-size information as well as a *frame-check* code. This last code is derived by the sending modem through an algorithm performed on all of the data in the frame. The technique is called *cyclic-redundancy checking (CRC).*

The receiving modem performs the same computation and checks to see if its results match the received CRC code. If the results match, the receiving modem sends a positive acknowledgement to the sending modem. Meanwhile, the sending modem keeps a copy of all frames it sends until each is positively acknowledged.

If the CRC codes don't match, the receiving modem initiates the *automatic repeat request (ARQ)* procedure. The receiving modem tells the sending modem which frame is in error, and doesn't accept any more frames until the frame in question is received correctly. The sending modem goes back to the specified frame, retransmits it, and continues from there. In this way the protocol protects against errors and also ensures that the data arrives in sequence.

FLOW CONTROL

When flow control is enabled, the modem stores data in a *buffer*, as shown in Figure A.2, and monitors how full the the buffer is.

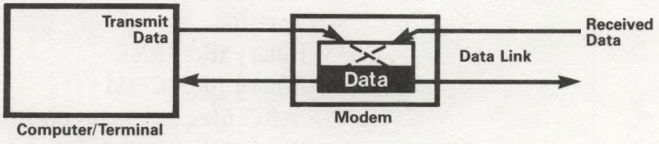


Figure A.2—Flow Control Buffer

The modem temporarily stores data transmitted from the computer or terminal as well as data received over the data link. Separate commands instruct the modem for Transmit Data flow control (&H*n*) and Received Data flow control (&I*n*, &R*n*). Chapter 4 contains instructions on when and how to use these commands.

Flow Control Examples

The labels used in the following examples indicate the following devices:

DTE *Data Terminal Equipment:* devices that are the source or final destination of transmitted data, such as a personal computer, mainframe, or terminal.

DCE *Data Communications Equipment:* also called Circuit-Terminating Equipment, for our discussion indicates the modems that establish and otherwise control the phone connection (data link).

Example 1—Transmit Data

The &H*n* command allows you to select software flow control, hardware flow control, or both. Under software flow control the modem sends the DTE the ASCII XON/XOFF characters described in Chapter 4. Under hardware control the modem raises or lowers the Clear to Send (CTS) signal via the RS-232C interface.

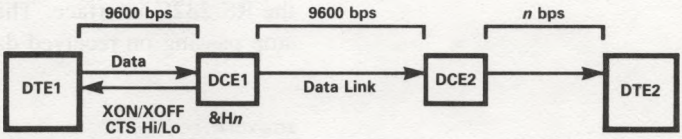


Figure A.3—Transmit Data Flow Control

Assume that there are disturbances on the line (line hits) and DCE2, the receiving modem, detects a transmitted frame error. DCE2 tells DCE1 to retransmit the frame and accepts no additional frames until it receives the affected frame correctly.

Meanwhile, the computer/terminal (DTE1) continues sending to DCE1, and data backs up in the buffer. As the buffer approaches capacity, DCE1 signals DTE1 to stop sending data. DCE1 also retransmits the specified frame and continues transmitting. When enough data is transmitted to half empty the buffer, DCE1 signals DTE1 to resume sending data.

As mentioned in Chapter 4, Transmit Data flow control is also essential if the DTE is set to send to the modem at a rate higher than the link rate.

Example 2—Received Data

It may be necessary or desirable to stop incoming data temporarily, for example, in order to review what's on the screen and take some kind of action. In the following diagram, the labels indicate operations when three different command options are used, as follows:

&I2 When the user at DTE1 sends an XOFF, DCE1 stops passing it data received over the data link. On receipt of an XON, DCE1 resumes.

&I5 DCE1 or DCE2 in ARQ Mode: Same as &I2.

DCE2 in non-ARQ Mode (no error control): When the user at DTE1 sends an XOFF, the signal passes through DCE1 with other data and is recognized by DTE2. DTE2 stops sending data, so that the buffer in DTE1 does not overflow.

&R2 DTE1 lowers the Request to Send (RTS) signal at the RS-232C interface. This signals the modem to stop passing on received data.

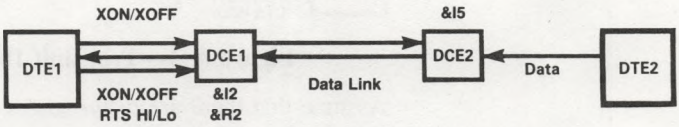


Figure A.4—Received Data Flow Control

Be sure to review Chapters 3 and 4 before using the error/flow control commands.

APPENDIX B
SUMMARIES AND TABLES

CONTENTS

B-1 The RS-232C Interface, with Pin Definitions

B-2 Front End Indicators

B-3 DIP Switch Summary

B-4 Default Settings

B-5 S-Register Summary

B-6 ASCII Chart

APPENDIX B-1
THE RS-232C INTERFACE, WITH PIN DEFINITIONS

DESCRIPTION

The RS-232C interface (often referred to without the "C") is a standard developed by the Electronic Industries Association (EIA). It defines the signals and voltages used when data is exchanged between a computer or terminal and a modem or serial printer. Data is transmitted between the devices via a cable with (typically) 25-pin connectors.

PIN ASSIGNMENTS

The entire standard covers many more functions than are used in most data communications applications. The pin assignments that are factory set in the Courier HST are shown in the following table.

RS-232C INTERFACE PIN DEFINITIONS

Pin	Circuit	Function	Signal Flow
2	BA	Transmitted Data	Terminal → Modem
3	BB	Received Data	Terminal ← Modem
4	CA	Request to Send	Terminal → Modem
5	CB	Clear to Send	Terminal ← Modem
6	CC	Data Set Ready	Terminal ← Modem
7	AB	Signal Ground	Terminal ↔ Modem
8	CF	Carrier Detect	Terminal ← Modem
12	SCF	Speed Indicate	Terminal ← Modem
20	CD	Data Terminal Ready	Terminal → Modem
22	CE	Ring Indicate	Terminal ← Modem

NOTE: Some computer/terminal equipment supports only a few of the RS-232C signal functions set in the Courier. *The minimum required for the modem to operate are Pins 2, 3, and 7, plus the Data Terminal Ready (DTR) override switch ON (DIP switch 1 DOWN).*

If the DTR override is OFF, Pin 20 is also required. If the modem is set for hardware flow control of transmitted data (&H1), Pin 5 is required. If the modem is set for hardware flow control of received data (&R2), Pin 4 is required.

APPENDIX B-2
FRONT END INDICATORS

Symbol	Meaning	Status
HS	High Speed	9600-bps calls only: ON during call progress, after completion of dialing; OFF during link negotiations at 2400 bps; ON during connection. Remains ON after disconnect until next call is originated or answered.
AA	Auto Answer/ Answer	Answer Mode only: ON when your modem is in Auto Answer Mode, and when answering a call; goes OFF if the channel is reversed and your modem transmits at 450 bps. Also goes off when the modem originates a call.
CD	Carrier Detect	ON when the CD override (DIP switch 6) is ON (DOWN). ON if DIP switch 6 is UP and the Courier receives a valid data signal (carrier) from a remote modem, indicating that data transmission is possible.
OH	Off Hook	ON when the Courier takes control of the phone line to establish a data link.
RD	Received Data	Flashes when a data bit is received by the Courier from the phone line, or when the modem is sending result codes to the terminal or computer.
SD	Send Data	Flashes when a data bit is sent to the Courier by the terminal or computer.
TR	Terminal Ready	ON when the DTR override (DIP switch 1) is ON (DOWN). ON if DIP switch 1 is UP and the modem receives a Data Terminal Ready signal from the terminal or computer via RS-232C Pin 20.
MR	Modem Ready/ Power	ON when the Courier is powered on. Flashes when the modems retrain, including online fallback to 7200 or 4800 bps.
RS	Request to Send	ON when the Courier is powered on if your computer supports RTS (Pin 4) on the RS-232C interface.*
CS	Clear to Send	ON until the modem lowers CTS (Pin 5) on the RS-232C interface when Transmit Data hardware flow control is enabled.
ARQ	Error Control	Automatic Repeat Request. ON when the Courier is set to &M4 or &M5 and successfully connects with another modem under error control.
AL	Analog Loopback	ON when the modem is in Analog Loopback Self-Test Mode.

* If RTS is supported and the Courier is set to &R2 for Received Data hardware flow control, the RS indicator goes OFF when the computer lowers RTS.

APPENDIX B-3
DIP SWITCH SUMMARY

PURPOSE

The Courier's DIP switches, located at the rear of the modem, are for adapting the modem to your equipment and personal requirements. You may also want to experiment and review your computer or terminal documentation as necessary.

Some users are able to move a single switch with a finger tip. If this doesn't work for you, use a toothpick or other small instrument.

OPERATIONS

The DIP switch settings are power-on defaults, read by the Courier when it is turned on. If changed when the modem is on, switches 2–5 and 9 require the ATZ (software reset) command to initiate the new settings. The remaining (hardware) switches are automatically operative when set UP or DOWN.

DIP SWITCHES: UP = OFF (OPEN), DOWN = ON (CLOSED)

Switch	Factory Setting	Function
1	DOWN	Data Terminal Ready Override UP DTR normal; RS-232C Pin 20 controls modem DOWN DTR always ON (override)
2	UP	Verbal/Numeric Result Codes UP Verbal (word) messages DOWN Numeric codes
3	DOWN	Result Code Display UP Quiet Mode, no display DOWN Result codes displayed
4	UP	Command Mode Local Echo UP Keyboard commands displayed DOWN Display of commands suppressed
5	DOWN	Auto Answer UP Modem answers on first ring DOWN Auto Answer suppressed
6	DOWN	Carrier Detect Override UP RS-232C Pin 8 indicates when modem is online and a carrier data signal is present DOWN Carrier Detect signal always ON (override)

Switch	Factory Setting	Function
7	UP	Single/Multiple Phone Installation UP Single phone line connection (RJ11 jack) DOWN Multiple phone installations (RJ12 or RJ13 jack); when the modem goes off hook the A/A1 leads on the RJ12 or RJ13 connector are shorted and the extension light goes on, indicating that the line is busy
8	DOWN	Command Set Recognition UP Command set recognition disabled (Dumb Mode) DOWN Normal operations (Smart Mode)
9	DOWN	Escape Code (+ + +) Operations UP When escape code is sent, modem hangs up, returns to Command Mode, displays NO CARRIER DOWN When escape code is sent, modem retains connection, returns to Command Mode, displays OK
10	UP	Power-on Software Defaults UP Load from NRAM DOWN Load factory settings from ROM
Quad Switch	UP	RS-232C Modem/Terminal Interface UP Normal assignments: Pin 2—terminal to modem; Pin 3—modem to terminal DOWN Alternate assignments: Pin 2—modem to terminal; Pin 3—terminal to modem *The need to change this setting is rare. Carefully review your computer or terminal documentation before turning this switch ON.*

APPENDIX B-4
DEFAULT SETTINGS

USER-PROGRAMMABLE DEFAULTS

You can create your own default configuration and store it in nonvolatile random access memory (NRAM) using the &W command described in Chapter 5. Your defaults are then loaded into random access memory (RAM) as long as DIP switch 10 is UP when you power on the modem. To view your NRAM settings at any time, use the ATI5 command.

The following tables list the options stored in NRAM. If DIP switch 10 is DOWN at power on, the factory settings listed in the table are loaded instead. The first time the modem is turned on, the NRAM settings are the same as the factory settings.

NRAM Options	Factory Setting	
Normal/error control modes	&M4	Normal/ARQ
Data Compression	&K1	Auto enable/disable
Display of error-control response codes	&A1	Enabled
Transmit data flow control	&HØ	Disabled
Received data software flow control	&IØ	Disabled
Received data hardware flow control	&R1	Ignore RTS
DTE rate select	&BØ	Follow connection rate
Link rate select	&NØ	Variable link operations
Data Set Ready (DSR) signal	&SØ	Override
Stored telephone number	&ZØ-3 = Ø	Blank
Tone/Pulse dialing	P	Pulse dial
Online local echo	F1	Echo OFF
Speaker control	M1	ON during dial through connect
Result code sets	X1	Extended
Pulse dial make/break ratio	&PØ	U.S./Canada
U.S./CCITT answer tone	BØ	U.S./Canada
Guard tone	&GØ	U.S./Canada
Break handling	&Y1	Clear buffer, send Break immediately
Word length*	7	
Parity*	1	Even parity

*Detected from AT command; determined by terminal/software setting.

NRAM S-Register Options	Factory Setting
Escape code character, ASCII	S2 = 43
Carriage Return character, ASCII decimal	S3 = 13
Line Feed character, ASCII decimal	S4 = 10
Backspace character, ASCII decimal	S5 = 8
Dial wait-time, sec.	S6 = 2
Carrier wait-time, sec.	S7 = 30
Dial pause/re-execute time, sec.	S8 = 2
Carrier Detect time, 1/10th sec.	S9 = 6
Carrier loss wait-time, 1/10th sec.	S10 = 7
Touch-Tone duration, spacing, msec.	S11 = 70
Escape code guard time, 1/50th sec.	S12 = 50
Bit-mapped functions	S13 = 0
Bit-mapped functions	S15 = 0
Inactivity/hang up timer	S19 = 0
Received break length, 10-msec. units	S21 = 10
XON character, ASCII	S22 = 17
XOFF character, ASCII	S23 = 19

APPENDIX B-5
S-REGISTER SUMMARY

USAGE

The default values are those users typically require. Change the settings with the ATS*r*=*n* command, where *r* is the register and *n* is a decimal value from 0–255:

ATS13=8 <cr>

The modem does not perform a value-range check. A value you select may not work with some equipment, and you'll have to readjust the setting.

To display the contents of a register, use ATS*r*? as in this example:

ATS20? <cr>

Register	Default	Function
S0	See DIP Switch 5	Sets the number of rings on which to answer when in Auto Answer Mode. Default = 1, equivalent of DIP switch 5 UP. S0=0 or DIP switch 5 DOWN (factory setting) suppresses Auto Answer.
S1	0	Counts and stores the number of rings from an incoming call.
S2	43	Stores the ASCII decimal code for the escape code character. Default character is "+". A value of 128–255 disables the escape code.
S3	13	Stores the ASCII decimal code for the Carriage Return character.
S4	10	Stores the ASCII decimal code for the Line Feed character.
S5	8	Stores the ASCII decimal code for the Backspace character. A value of 128–255 disables the Backspace key's delete function.
S6	2	Sets the number of seconds the modem waits before dialing. If set to X2, X4, X6, or X7, the modem ignores this register and dials as soon as it detects a dial tone (fast dials).
S7	30	Sets the number of seconds the modem waits for a carrier. May be set for much longer duration if, for example, the modem is originating an international connection.
S8	2	Sets the duration, in seconds, for the pause (,) option in the Dial command and the pause between command re-executions (> and A> commands).

Register	Default	Function
S9	6	Sets the required duration, in tenths of a second, of the remote modem's carrier signal before recognition by the Courier (Carrier Detect Time).
S10	7	Sets the duration, in tenths of a second, that the modem waits after loss of carrier before hanging up.
S11	70	Sets the duration and spacing, in milliseconds, of dialed Touch-Tones.
S12	50	Sets the duration, in fiftieths of a second, of the guard time for the escape code sequence.
S13	Ø	Bit-mapped register. Select the bit(s) you want on, and set S13 to the total of the values in the "Value" column. For example, ATS13=20 enables bits 2 (value = 4) and 4 (value = 16).

Bit	Value	Result
Ø	1	Reset on dropping of DTR
1	2	Reverse normal Auto Answer operation: on incoming RING, enter Originate Mode and look for Answer tone
2	4	Disable 250 msec. pause before result code display
3	8	On DTR signal, Auto Dial the number stored in NRAM at position Ø
4	16	At power on or reset, Auto Dial the number stored in NRAM at position Ø
5	32	Reserved
6	64	Disable MNP Level 3 (used for testing Level 2)
7	128	Watchdog hardware reset, same as power on (used in factory testing)

S14		Reserved.

Register	Default	Function
S15	Ø	Bit-mapped register. See instructions for S13, above.

Bit	Value	Result
Ø	1	Disable the modem's extra high-frequency equalization if it causes problems on shorter-link calls
1	2	Disable 7200/4800 bps online fallback
2	4	Disable 450-bps back channel, force 300-bps back channel
3	8	Reset non-ARQ mode Transmit buffer from 1.5k bytes to 128 bytes*
4	16	Disable MNP Level 4; retransmitting the larger Level 4 data blocks may be a problem if you expect a great number of errors during a call
5	32	Set Del key to act as Backspace key: provided for specialized applications. May cause software incompatibility in standard applications.
6	64	Some earlier 2400-bps MNP modems, not made by USRobotics or Microcom, were not fully compatible with the MNP protocol. If you have difficulty making a successful 2400-bps MNP connection with a remote MNP modem, it may be because of this incompatibility. Set S15 to 64 and try again to make the connection.
7	128	Enable InterBridge network compatibility. May cause software incompatibility in standard applications.

* The default 1.5k byte non-ARQ buffer allows data transfer with X- and YMODEM-type file transfer protocols without using flow control.

The 128-byte option allows remote users with slower modems to stop data you're transmitting from scrolling off their screens. When remote users send your computer an XOFF (Ctrl-S) and you stop transmitting, the data in transit from your modem's buffer doesn't exceed the size of their screen.

Register	Default	Function
S16	0	Modem self-test. See Appendix E-6 for test procedures. 0 Data Mode (no testing) 1 Analog Loopback 2 Dial Test 4 Test Pattern 5 Analog Loopback with Test Pattern
S17	0	Stores the reason for a received ARQ Link Disconnect. May be requested by Technical Support if you're having a problem connecting in ARQ mode with another ARQ-mode modem. At ATS17? the modem returns one of the following codes: 1 Received data unit other than link request 2 Incompatible protocol level 3 Unknown parameters in link request 4 Remote modem retry timeout (Max. 12 tries) 5 Inactivity timeout 6 Destination user not found 254 Peer protocol error 255 User-initiated disconnect
S18		Reserved.
S19	0	Sets the duration, in minutes, for the Inactivity Timer. The timer is activated when there is no activity on the phone line. At the timeout the Courier hangs up.
S20	0	Stores the reason for the NO CARRIER result code. At ATS20? the modem returns one of the following codes: 0 Key press abort 1 DTR dropped 2 Escape code (+ + +) issued 3 Loss of Carrier 4 Inactivity timeout 5 Automatic hangup with ARQ incompatibility (&M5 Mode) 6 ARQ Retry timeout (Max. 12 tries) 7 ARQ Received Link Disconnect (See S17)
S21	10	Sets, in 10-millisecond units, the length of Breaks sent from the modem to the local terminal.
S22	17	Stores the ASCII decimal code for the XON character.
S23	19	Stores the ASCII decimal code for the XOFF character.

APPENDIX B-6
ASCII CHART

ASCII CHART												
DEC	HEX	CHAR	DEC	HEX	CHAR	DEC	HEX	CHAR	DEC	HEX	CHAR
00	00	NUL	32	20	SP	64	40	@	96	60	`
01	01	SOH	33	21	!	65	41	A	97	61	a
02	02	STX	34	22	"	66	42	B	98	62	b
03	03	ETX	35	23	#	67	43	C	99	63	c
04	04	EOT	36	24	$	68	44	D	100	64	d
05	05	ENQ	37	25	%	69	45	E	101	65	e
06	06	ACK	38	26	&	70	46	F	102	66	f
07	07	BEL	39	27	'	71	47	G	103	67	g
08	08	BS	40	28	(	72	48	H	104	68	h
09	09	HT	41	29	)	73	49	I	105	69	i
10	0A	LF	42	2A	*	74	4A	J	106	6A	j
11	0B	VT	43	2B	+	75	4B	K	107	6B	k
12	0C	FF	44	2C	,	76	4C	L	108	6C	l
13	0D	CR	45	2D	–	77	4D	M	109	6D	m
14	0E	SO	46	2E	.	78	4E	N	110	6E	n
15	0F	SI	47	2F	/	79	4F	O	111	6F	o
16	10	DLE	48	30	0	80	50	P	112	70	p
17	11	XON	49	31	1	81	51	Q	113	71	q
18	12	DC2	50	32	2	82	52	R	114	72	r
19	13	XOFF	51	33	3	83	53	S	115	73	s
20	14	DC4	52	34	4	84	54	T	116	74	t
21	15	NAK	53	35	5	85	55	U	117	75	u
22	16	SYN	54	36	6	86	56	V	118	76	v
23	17	ETB	55	37	7	87	57	W	119	77	w
24	18	CAN	56	38	8	88	58	X	120	78	x
25	19	EM	57	39	9	89	59	Y	121	79	y
26	1A	SUB	58	3A	:	90	5A	Z	122	7A	z
27	1B	ESC	59	3B	;	91	5B	[	123	7B	{
28	1C	FS	60	3C	<	92	5C	\	124	7C	|
29	1D	GS	61	3D	=	93	5D	]	125	7D	}
30	1E	RS	62	3E	>	94	5E	^	126	7E	~
31	1F	US	63	3F	?	95	5F	_	127	7F	DEL

APPENDIX C
ALPHABETICAL COMMAND SUMMARY

Additional command summaries are on the bottom panel of the modem and in the Quick-Reference Card.

Requirements

1. Type commands in either upper or lower case.
2. All commands except A/, A> and + + + are preceded by the AT prefix and are executed with the Enter/Carriage Return key (<cr>).
3. Command length = 40 characters maximum. The modem doesn't count the AT prefix, Carriage Return character, or spaces. It counts but doesn't act on punctuation such as hyphens and parentheses.
4. A missing numeric parameter is assumed to be zero, as in the command to hang up: ATH <cr> is the equivalent of ATH0 <cr>.

BASIC COMMAND SET

Command/ Options	Function
&	See the Extended Command Summary that follows this Basic Set.
A	Force Answer Mode when the modem hasn't received an incoming call.
A/	Re-execute the last issued command one time. A/ doesn't take the AT prefix or a Carriage Return.
A>	Re-execute the last issued command continuously until canceled by pressing <any key>. Dial strings are re-executed ten times after which execution terminates. A> doesn't take the AT prefix or a Carriage Return.
<Any key>	Terminate current dialing operation resulting from an issued Dial command; terminate Repeat mode (> or A>).
AT	Attention: lets the modem know commands are being issued to it. *Must* precede all other commands except A/, A> and + + +.
B*n*	U.S./CCITT answer sequence.
B0	CCITT (overseas) answer sequence.
B1	U.S. answer sequence (Default).

C*n*	Transmitter enabled/disabled.
C0	Transmitter disabled; receive-only condition.
C1	Transmitter enabled (Default).
D	Dial the number that follows and enter Originate Mode. Optional parameters:
P	Pulse dial (Default).
T	Touch-Tone dial.
,	(Comma) Pause for 2 seconds.
;	Return to Command Mode after dialing.
"	Dial the letters that follow.
!	Transfer call (flash switch-hook).
W	Wait for second dial tone (with X3 or higher).
@	Wait for an answer (with X3 or higher).
R	Reverse frequencies.
DS*n*	Dial the phone number stored in NRAM at position *n* (*n* = 0–3).
E*n*	Command Mode local echo (display) of keyboard commands ON/OFF. (DIP switch 4 is factory set to Command Mode echo ON.)
E0	Local echo OFF.
E1	Local echo ON.
F*n*	Online local echo of transmitted data ON/OFF. Sometimes referred to as the Duplex setting.
F0	Local echo ON. Sometimes called Half Duplex. Modem sends a copy to your screen of data it sends to the remote system.
F1	Local echo OFF (Default). Sometimes called Full Duplex. Receiving system may send a remote echo of data it receives.
H*n*	On/off hook control.
H0	Hang up (go on hook).
H1	Go off hook.

I*n*	Inquiry.
I0	Display product code.
I1	Display results of ROM checksum.
I2	Display results of RAM test.
I3	Display call duration or real time (see K*n*).
I4	Display current modem settings.
I5	Display NRAM settings.
I6	Display Link diagnostics.
I7	Display product configuration.
K*n*	Modem clock operation: Call-duration or Real-time Mode.
K0	Return call duration at ATI3 (Default).
K1	Return actual time at ATI3. Clock is set using ATI3 = HH:MM:SS K1.
M*n*	Monitor (speaker) control.
M0	Speaker always OFF.
M1	Speaker ON until carrier is established (Default).
M2	Speaker always ON.
M3	Speaker ON after last digit dialed and until carrier is established.
O	Return online after command execution.
P	Pulse dial (Default).
Q*n*	Quiet Mode: result codes displayed/suppressed. (DIP switch 3 is factory set to display result codes.)
Q0	Result codes displayed.
Q1	Result codes suppressed (''quiet'').
S*r*=*n*	S-register commands: *r* is any S-register; *n* must be a decimal number between 0 and 255.
S*r*?	Query register *r*.
T	Tone dial.

V*n* Return result codes in words or numbers (Verbal/Numeric Mode). (DIP switch 2 is factory set to verbal result codes.)

V0 Numeric Mode.

V1 Verbal Mode.

X*n* Result code set options. Use the following table (Default = X1, Extended set, codes 0–5, 10 and 13).

RESULT CODES OPTIONS TABLE

	Commands							
	X0	X1	X2	X3	X4	X5	X6	X7
Result codes								
0/OK	X	X	X	X	X	X	X	X
1/CONNECT	X	X	X	X	X	X	X	X
2/RING	X	X	X	X	X	X	X	X
3/NO CARRIER	X	X	X	X	X	X	X	X
4/ERROR	X	X	X	X	X	X	X	X
5/CONNECT 1200		X	X	X	X	X	X	X
6/NO DIAL TONE			X		X		X	X
7/BUSY				X	X	X	X	X
8/NO ANSWER				X	X	X	X	X
9/Reserved								
10/CONNECT 2400		X	X	X	X	X	X	X
11/RINGING						X	X	X
12/VOICE						X	X	
13/CONNECT 9600		X	X	X	X	X	X	X
Functions								
Adaptive Dialing			X	X	X	X	X	X
Wait for 2nd Dial Tone (W)				X	X	X	X	X
Wait for Answer (@)				X	X	X	X	X
Fast Dial			X		X		X	X

NOTE: Depending on the &A setting, the following result codes are enabled/disabled. The default is &A1, /ARQ codes enabled.

15 CONNECT 1200/ARQ
16 CONNECT 2400/ARQ
17 CONNECT 9600/ARQ

Z	Reset the modem to its NRAM settings; initiate new settings of DIP switches 2–5 and 9.
+ + +	Escape code, preceded and followed by a guard time of at least one second of no data transmission. The modem responds to + + + by returning to Command Mode and doing the following: DIP Switch 9 DOWN (ON, Factory setting): Retains phone line connection Sends OK result code DIP Switch 9 UP (OFF): Hangs up Sends NO CARRIER result code
>	Repeat the command continuously until canceled by pressing <any key>. If used in a Dial string, automated redialing terminates after ten attempts.
/	(Slash) Pause 125 milliseconds.
$	Help command summary request.
&$	Help extended command summary request.
D$	Help Dial command summary request.
S$	Help S-register summary request.
<Ctrl>-S	Stop/restart display of Help screens.
<Ctrl>-C or <Ctrl>-K	Cancel display of Help screens.

EXTENDED COMMAND SET

Command/ Options	Function
&A*n*	Enable/disable /ARQ result codes.
&A0	Suppress /ARQ result codes.
&A1	Display /ARQ result codes (Default).
&B*n*	Data Rate, terminal-to-modem (DTE/DCE) variable or fixed.
&B0	DTE/DCE rate follows connection rate (Default).
&B1	DTE/DCE fixed at the DTE setting. Allowable rates are 19.2k, 9600, 7200, 4800, 2400, 1200, 300 bps.
&F	Load factory (ROM) settings into random access memory (RAM).
&G*n*	Guard tone follows answer tone, United Kingdom and some Commonwealth Countries.
&G0	No guard tone, U.S. and Canada (Default).
&G1	Reserved.
&G2	1800 Hz guard tone follows answer tone. Requires B0 setting.
&H*n*	Transmit Data flow control.
&H0	Flow control disabled (Default).
&H1	Hardware (CTS, Pin 5) flow control.
&H2	Software (XON/XOFF) flow control.
&H3	Hardware and software control.
&I*n*	Received Data software flow control.
&I0	Flow control disabled (Default).
&I1	XON/XOFF to local modem and remote computer.
&I2	XON/XOFF to local modem only.
&I3	Host Mode, Hewlett Packard protocol.
&I4	Terminal Mode, Hewlett Packard protocol.
&I5	XON/XOFF to remote modem for non-ARQ link flow control.

&K*n*	Data compression enabled/disabled.
&K0	Disabled.
&K1	Auto enable/disable (Default). Disabled if &B and &N rate settings are equal.
&K2	Enabled regardless of &B and &N settings.
&M*n*	Normal or Error Control Modes.
&M0	Normal Mode.
&M1	Reserved.
&M2	Reserved.
&M3	Reserved.
&M4	Normal/ARQ Mode—Normal if ARQ connection cannot be made (Default).
&M5	ARQ Mode—hang up if ARQ connection cannot be made.
&N*n*	Link Data Rate (DCE/DCE) variable or fixed. With fixed link rate, modem hangs up if called or calling modem is operating at a different rate.
&N0	Variable link operations; negotiate highest possible link rate with remote modem (Default).
&N1	300 bps.
&N2	1200 bps.
&N3	2400 bps.
&N4	4800 bps.
&N5	7200 bps.
&N6	9600 bps.
&P*n*	Pulse dialing make/break ratio.
&P0	U.S./Canada make/break ratio (Default).
&P1	U.K./Some Commonwealth countries make/break ratio.
&R*n*	Received Data hardware flow control (RTS, Pin 4).
&R0	Reserved.
&R1	Ignore RTS (Default).
&R2	Received data output to terminal on RTS high; used only if terminal supports RTS (Pin 4).

&S*n*	Data Set Ready (DSR, Pin 6) override.
&S0	DSR override, always ON (Default).
&S1	Modem controls DSR.
&W	Write current settings to nonvolatile random access memory (NRAM).
&Y*n*	Break handling. Destructive Breaks clear the buffer; expedited Breaks are sent immediately to the remote system. Under data compression, destructive Breaks reset the local and remote modems' compression tables.
&Y0	Destructive, don't send Break.
&Y1	Destructive, expedited (Default).
&Y2	Nondestructive, expedited.
&Y3	Nondestructive, unexpedited; modem sends Break in sequence with data received from terminal equipment.
&Z*n*=*s*	Write the following Dial string (*s*) to NRAM at position *n* (*n* = 0–3). Maximum length of *s* is 36 characters.
&Z*n*?	Display the phone number stored in NRAM at position *n*.

APPENDIX D
PROBLEMS AND SOLUTIONS

You may occasionally encounter one of the problems listed here. They are divided into two categories: before and during the exchange of user information over the data link.

PROBLEM	SUGGESTED SOLUTION
Before Establishment of the Data Link	
Your modem . . .	
Doesn't answer the phone or go "off hook" to dial a number	Check to make sure your computer or terminal is providing a positive voltage on pin 20 (Data Terminal Ready) of the RS-232C connector. ➤ See Appendix B-3, DIP switch 1.
Doesn't respond OK when you type AT <cr>	1. Make sure you're typing in either upper case or lower case letters, not a combination, and that you type a Carriage Return. 2. If you're using a computer, make sure it is in Terminal Mode. 3. Check to see that your terminal or software is set to the correct bit rate and word length (7 bits with or without a parity bit, or 8 bits and no parity). If you're using a computer, make sure your software is set to the correct communications port. 4. Check that DIP switch 3 is DOWN, for result code display, and that DIP switch 2 is UP, for verbal result codes. If not, change the switch(es) and issue ATZ <cr>. Or issue whichever of these commands is needed: ATQ0 <cr> (to display the message) ATV1 <cr> (to display a verbal message) 5. Your machine may require the Carrier Detect override (DIP Switch 6 DOWN), but you've changed the factory setting. Check Appendix B-3. 6. A rare condition is that your terminal/computer reverses the send/receive functions of RS-232C pins 2 and 3. ➤ See Appendix B-1, Appendix B-3, Quad switch, and your equipment documentation.

PROBLEM	SUGGESTED SOLUTION
Before Establishment of the Data Link	
Your computer . . .	
Reacts as though a data link has been established, but no call has been received	DIP Switch 6 is set DOWN at the factory for Carrier Detect override, but your system may be reacting to improper signals received on pin 8 of the RS-232C connector. Set DIP switch 6 UP (OFF).
When the modem is in Answer Mode, acts as if a Carriage Return has been entered, but nothing has been typed at the keyboard	Your software may be misreading signals from the modem as it automatically sends a Carriage Return and a Line Feed before and after the RING and CONNECT messages. Entering the Quiet Mode command, ATQ1 <cr>, should solve the problem.
Both modems . . .	
Exchange carrier signals, but fail to establish a communications link	1. Check to make sure the proper bit rate, word length, parity and number of Stop bits have been selected. 2. If that doesn't correct the problem, it's likely that the quality of the phone connection is poor and that the other modem is missing the signals your modem is transmitting. The variable quality of phone line connections may be due to any number of conditions in the phone service's equipment or the current environment. Try several calls, and if you still can't get through, try calling another modem. If the second modem accepts your call, the problem lies with the modem you first tried to call. 3. Make sure the modem at the other end of the line is USR-HST compatible at 9600 bps, V.22bis-compatible at 2400 bps, Bell 212A-compatible at 1200 bps, or Bell 103-compatible at 300 bps. These are the common signaling standards for full duplex dial-up network transmission in the U.S.

PROBLEM	SUGGESTED SOLUTION
During Data Transfer	
Your screen displays . . .	
Only brackets	Check to make sure both modems are at the same bit rate, word length, parity and number of Stop bits. If the settings are correct, the problem may be with the phone line. Try the following measures: 1. Try placing the call again. The phone company routes even local calls differently each time you call. 2. Try calling a different modem to see if the problem persists. (However, if it does, the problem may still be with the phone line.) 3. If you are using a long-distance service and the problem persists, you might try using a different service.
Random (garbage) characters	Make sure both modems are set at the same bit rate, word length, parity, and number of Stop bits.
Double characters	The modem's online local echo is probably ON. If the modem's in Normal Mode, return it to Command Mode (use + + +) when it's convenient, and then type: ATF1 <cr> If the modem's in an ARQ connection the only alternatives are to put up with the problem until you disconnect or to hang up (type + + +), issue the ATF1 command, and call again.

IF YOU STILL HAVE PROBLEMS

The problems described above are by far the most common ones that users encounter. If the suggestions we've given don't clear up your difficulties, try the following:

1. Review the manual carefully to see if you've missed something.
2. Call or visit your dealer. Chances are your dealer will be able to give you the assistance you need. This is much more efficient and time-saving than returning the modem to USRobotics.

3. If your dealer can't clear up your difficulties, call the USRobotics Technical Support Department at 800/982-5151 (in Illinois, 312/982-5151). Our Service Representatives will be happy to give you assistance over the phone Monday through Friday from 8:30 a.m. to 5 p.m. (Central Time Zone).

4. If necessary, the Service Representative you talk to may give you a Return Materials Authorization (RMA) number. *Modems without an RMA number will not be accepted.*

5. If you do return the modem to us, please follow this procedure—

   a. Ship the unit, postage paid, in its original container. If the original container is not available, pack the modem carefully in a strong box of corrugated cardboard with plenty of packing material.

   b. Be sure to include your RMA number inside the package, along with your name and address. *Put your return address and your RMA number on the shipping label as well.*

   c. Ship the well-packed modem to the following address.

      Technical Support Department
      USRobotics, Inc.
      8100 North McCormick Boulevard
      Skokie, Illinois 60076

   d. Please note that USRobotics will not accept packages sent COD, so be sure to send the modem postage paid.

   e. USRobotics will repair your modem and return it to you via United Parcel Service.

APPENDIX E
ADDITIONAL OPERATIONAL INFORMATION

CONTENTS

E-1 Using Both Voice and Data Communications

E-2 High Speed/Low Speed Protocol

E-3 Retrain Sequence

E-4 PBX, Dedicated Line, and Leased Line Operations

E-5 Hewlett Packard Installations

E-6 Analog Loopback and Other Tests

APPENDIX E-1
USING BOTH VOICE AND DATA COMMUNICATIONS

When you assemble the Courier, you have the option of plugging your phone into the second modular jack of the modem so it's available for voice calls. You can also use the phone to synchronize communications with another user whose modem uses the AT command set, such as a USRobotics or USRobotics-compatible modem.

PREPARATION

First call the other user to establish the bit rate, parity, word length and number of Stop bits the other person's modem accepts. Then both of you can turn the call over to your modems.

COMMANDS

1. Without hanging up the phone, have your modem go off hook in Originate Mode. Type the following command:

   ATD <cr>

   NOTE: Be sure the modem is not set to X2, X4, X6, or X7, or it will return the NO DIAL TONE result code and hang up.

2. The other party should then have the remote modem go off hook in Answer Mode. The following command is used to do this:

   ATA <cr>

3. Now both of you can hang up your respective phones while the two modems establish the data link. They will maintain the link until one of you gives your modem a command to disconnect.

Either party's device can be the originate or answer modem: it doesn't matter who made the phone call. But one modem must first enter Originate Mode and the other then enter Answer Mode. You and the other party, therefore, must agree on which command, ATD or ATA, you will each use.

NOTE: It may happen that spurious "garbage" characters will appear on the screen when you hang up the phone. You can avoid these by hanging up the phone as soon as you hear the modem go off hook, during the one or two seconds it takes the two modems to establish the link.

APPENDIX E-2
HIGH SPEED/LOW SPEED PROTOCOL

OVERVIEW

This appendix is intended for those users who want to try programming their computers to switch bit rates to match the Courier HST's connection rate. The material here applies only when the modem is set for variable rates at both the DTE (computer) and link interfaces, &BØ and &NØ, respectively.

In both Originate or Answer Modes, if the link rate is set to &NØ the Courier HST negotiates with the remote modem to connect at the highest possible rate. In addition, if the modem is set to the Extended or Advanced result codes (X1 or higher) it signals the DTE with one of the following result codes or, unless the call is at 300 bps, an /ARQ Mode equivalent:

CONNECT	(300 bps)
CONNECT 1200	(1200 bps)
CONNECT 2400	(2400 bps)
CONNECT 9600	(9600 bps)

The modem sends the result code at its previous rate. Then it switches to the new connection rate.

If your computer doesn't switch rates and you want to program it to do so, use the example on the next page as a guide. It demonstrates the occurrence of the CONNECT codes in the connection sequence, so that recognition of the codes can be used to switch the computer. The example uses a sequence of incoming calls, but the codes apply to Originate Mode connections as well.

The example assumes the following settings:

Software: initially 9600 or 19.2k bps, allowing the full range of link rates:
9600/7200/4800/2400/1200/300 bps

Modem: X1 or higher (rate-specific CONNECT codes)
&BØ (variable DTE rate)
&NØ (variable link rate)

Example

Action	Modem Response	DTE/DCE Rate
1. Power on.		9600
2. 300-bps call comes in.	RING CONNECT	9600 9600
3. Data link is established. Data transfer takes place.		300
4. Data session is over. Call is ended; loss of carrier.	NO CARRIER	300
5. 2400-bps call comes in.	RING CONNECT 2400	300 300
6. Data link is established. Data transfer takes place.		2400
7. Data session is over. Call is ended; loss of carrier.	NO CARRIER	2400
8. 9600-bps call comes in.	RING CONNECT 9600	2400 2400
9. Data link is established. Data transfer takes place.		9600
10. Data session is over. Call is ended; loss of carrier.	NO CARRIER	9600

Explanation

1. The modem is powered on and is operating at 9600 bps. If the software is then set to 19.2k bps and an AT command sent, the DTE/DCE rate would be 19.2k bps.
2. A 300-bps modem calls. The Courier senses the incoming signal and sends the messages RING and CONNECT to the computer. These messages are sent at 9600 (or 19.2k) bps, the current rate.
3. Since the Courier responds CONNECT, rather than CONNECT 1200, 2400, or 9600, the computer switches to 300 bps. The modem automatically shifts to 300 bps to accept the data from the incoming call.

4. The 300-bps data session is terminated; the modem sends the message NO CARRIER at 300 bps.
5. A 2400-bps call comes in. The modem responds RING and CONNECT 2400. These message are sent at the current bit rate of 300 bps.
6. The computer, receiving the CONNECT 2400 message, adjusts accordingly to the higher bit rate. The modem also shifts to 2400 bps.
7. The 2400-bps data session is terminated; the modem sends the message NO CARRIER at 2400 bps.
8. A 9600-bps call comes in. The modem responds RING and CONNECT 9600. These message are sent at the current bit rate of 2400 bps.
9. The computer, receiving the CONNECT 9600 message, adjusts accordingly to the higher bit rate. The modem also shifts to 9600 bps.
10. The 9600-bps data session is terminated; the modem sends the message NO CARRIER at 9600 bps.

NOTE: If online fallback occurs during a 9600-bps call, the modem does not send CONNECT result codes for 7200- or 4800-bps link rates.

Keep in mind that whether or not your computer adjusts to these rate changes, the Courier automatically shifts to the connection rate if it is set to &BØ.

APPENDIX E-3
RETRAIN SEQUENCE

DESCRIPTION

The retrain sequence occurs at 2400 and 9600 bps. It is a resynchronization sequence performed when one of the connected modems senses that problems on the line may affect data reliability. The procedure is essentially transparent to users.

The following is an example of retrain events:

1. The Courier HST's receiver, sensing a need to retrain, clamps RX to MARKs.
2. The remote modem, after receiving about 100 ms of analog signals (a pattern of ?~?~ is usually output), clamps RX data to MARKs.
3. After the training sequence, approximately one second, the Courier unclamps RX data and turns HS ON.
4. The remote modem reenters Data Mode.

APPENDIX E-4
PBX, DEDICATED LINE, AND LEASED LINE OPERATIONS

The following operations apply in installations where the modem is not directly connected to the public-access switched telephone network.

Key System PBX Installations (RJ12/RJ13 Jacks)

RJ12 and RJ13 phone jacks have two leads (A and A1) in addition to those on the common RJ11 jack. When the connected phone or modem goes off hook, the A/A1 leads are shorted, causing the PBX off-hook indicator for that extension to light, indicating that the line is busy. If you're using either an RJ12 or RJ13 jack, set DIP switch 7 DOWN so that the off-hook indicator lights when the modem goes off hook.

Calling an Outside Party

To have the modem make an outside call, follow the auto-dial instructions in Chapter 6, but insert the sequence used to obtain an outside line, followed by a comma, before the phone number in the Dial command.

The off-hook indicator on the PBX should show the extension as busy if DIP switch 7 is DOWN.

Internal Calling

To call another modem on the system, use the Dial command described in Chapter 6 with the number of the extension you wish to call. If set to Auto Answer, the called modem automatically answers on the incoming ring. The off-hook indicators on the PBX should show both extensions as busy if DIP switch 7 is DOWN on both modems.

User-Installed or Leased Telephone Line

These lines are often referred to as dedicated or private lines. User-installed lines are most commonly 2-wire lines, similar to the 2-wire lines that connect residential phones to the public switched network. Lines leased from the telephone company are 4-wire lines, often designated as 3002 Analog Circuits. In some installations the telephone company also installs 4-wire to 2-wire converters at each end of the connection. For optimal operations, we recommend that the physical length of these lines not exceed 5 miles.

In both types of installation there is a continuous point-to-point connection between two modems. No dialing of phone numbers is required. To establish the connection, follow these steps:

1. Decide which modem is to be the Originate modem and which the Answer modem. The originate and answer frequencies must be defined for the modems to communicate.

2. First put the calling modem in Originate Mode with the manual Dial command:

   ATD <cr>

   NOTE: Be sure the modem is not set to X2, X4, X6, or X7, or it will return the NO DIAL TONE result code and hang up.

3. Then put the answering modem in Answer Mode with the manual Answer command:

   ATA <cr>

NOTE: If there is an interruption in the communications link (a strike to the line due to weather or some other problem), repeat steps 2 and 3 to reestablish the link.

APPENDIX E-5
HEWLETT PACKARD INSTALLATIONS

The Courier HST recognizes the ASCII ENQ/ACK characters exchanged between the Hewlett Packard host computer and its terminals. The HP host sends the terminal an ENQ character at predefined intervals, and sends no more data until the terminal responds with an ACK character.

Courier HST modems manage this ENQ/ACK protocol so that communication is speeded up, thereby enabling HP terminals to achieve high speeds on dial-up lines. Special Received Data flow control settings (the &I command) *are required for HP users.*

Follow these guidelines:

1. Use one of the &I settings given here for both Normal and error control (ARQ) sessions, i.e., for all &M settings.
2. Do not use a software setting for Transmit Data flow control. Set the modem only to &H0 or &H1, according to the guidelines in Chapter 4.
3. Set the Courier HST to Host Mode if it is attached to the host computer, or to Terminal Mode if it is attached to a terminal:

Host Mode	AT&I3 <cr>
Terminal Mode	AT&I4 <cr>

APPENDIX E-6
ANALOG LOOPBACK AND OTHER TESTS

ANALOG LOOPBACK SELF-TEST

This test is a way to check that the modem's transmitter and receiver are working properly. During Analog Loopback, data from the computer is sent in a loop through the transmitter (where it is modulated) and the receiver (where it is demodulated), and returned to the screen. Due to asymmetrical modulation at 9600 bps, the test must be performed at 2400 bps or below.

You can use the modem's internal test pattern as data, or type your own at the keyboard. Follow these procedures to test the modem by sending the test pattern:

NOTE: If the modem is set to X2, X4 X6, or X7 it will return the NO DIAL TONE result code and hang up. Send the modem a different X setting.

1. Set your terminal or software to 2400 bps and send the modem the following command, which has the results listed below.

   AT &M0 S16=5D <Enter>

&M0	Sets the modem to Normal Mode. If the modem is set for error control (&M4 or &M5) you can't tell if there is a problem because the modem checks for errors and automatically retransmits any errored data.
S16=5	Sets S-Register 16 to Analog Loopback with test pattern. The modem sends, modulates and demodulates its internal test pattern and returns that pattern to your screen.
D	The Dial command selects testing the Originate (Dial) frequency. The Answer command (A) tests the Answer frequency.

   The modem enters Analog Loopback Mode, goes off hook, sends the message CONNECT 2400 to the screen, and then sends the test pattern.

2. When you're satisfied with the test, terminate the operation by pressing any character key on the keyboard. The modem goes back on hook and responds with the message NO CARRIER.

3. Reset the error control default and reset S-Register 16 to zero, for data operations, by entering this command:

AT &M4 S16=0 <Enter>

Normal/Test Frequencies

In normal operations, communicating modems transmit at different frequencies within the communications channel, one low and the other high. The calling modem is said to be in Originate Mode: it transmits at the low (Originate) frequency and receives at the high frequency. The answering modem, in Answer Mode, transmits at the high (Answer) frequency, and receives on the low frequency.

During Analog Loopback testing, the modem transmits and receives on the same frequency, either Originate (low) or Answer (high). The Analog Loopback command in the previous section tests the Originate frequency.

Testing the Answer Frequency

To test the Answer frequency, substitute the Answer command, A, as follows:

AT &M0 S16=5A

ADDITIONAL TESTS

In all, S-register 16 has five settings, as follows.

0 Data Mode (normal operations)
1 Analog Loopback
2 Dial Test
4 Test Pattern
5 Analog Loopback with Test Pattern

NOTE: After any testing, be sure to reset S-register 16 for Data Mode, with or without the default error control setting (&M4):

AT &M4 S16=0 <Enter>

S16=1

1. Select this option to perform analog loopback testing by sending your own data instead of the test pattern. Use either of the following commands after setting your terminal or software to 2400 bps. If the modem is set for error control, insert &M0 before the S16 command.

ATS16=1D <Enter>

ATS16=1A <Enter>

2. When the modem displays the message CONNECT 2400, type any message you wish at the keyboard. It is looped through the modem and returned to the screen.

3. End the test by not typing anything for at least one second and then typing the escape code that brings the modem back to Command Mode. (Do not type the AT prefix or press the Enter key.)

   + + +

4. The modem returns the OK message. Reset the error control default and reset S-Register 16 to zero, for data operations, by entering this command:

   AT &M4 S16=0 <Enter>

S16=2 The Dial Test is used for factory testing the frequencies of Touch-Tone values. When S-register 16 is set to 2 and a single Touch-Tone is dialed (e.g., ATD7), the modem continues to transmit that tone until another Carriage Return is entered. This test is rarely needed by users.

S16=4 The Test Pattern alone is used for testing equipment and the phone line. If S16 is set to 4 and a Dial command issued, the Courier transmits the test pattern upon connection to the remote system. If set for Auto Answer the Courier transmits the test pattern when it answers a call. Be sure to reset S16 to zero for normal calls.

Testing at 1200 BPS To test the modem at 1200 bps, follow the previous instructions, but first set your software to 1200 bps.

Testing at 300 BPS The Test Pattern is not available at 300 bps. Analog Loopback testing is done at 300 bps by setting your software to 300 bps and setting S-16 only to 1D or 1A.

NOTE: It might happen that you have issued either S16=1 or 5 and the modem is in Analog Loopback Mode, but you haven't yet sent a Dial or Answer command to initiate testing. If the modem is also set for Auto Answer and a call comes in, the Courier resets S16 to zero and answers the call.

APPENDIX F
TECHNICAL SPECIFICATIONS

Compatibility	USR-HST, 9600 bps, asynchronous, asymmetrical (9600/450 bps with automatic handshake adjustment to 300-bps), trellis-coded modulation, Quadrature Amplitude Modulation (QAM)
	USR-HST, 7200 bps, asynchronous, asymmetrical (9600/450 bps with automatic handshake adjustment to 300-bps), trellis-coded modulation, Quadrature Amplitude Modulation (QAM)
	USR-HST, 4800 bps, asynchronous, asymmetrical (9600/450 bps with automatic handshake adjustment to 300-bps), unencoded Quadrature Amplitude Modulation (QAM)
	CCITT recommendation V.22*bis*, 2400 bps, asynchronous, Quadrature Amplitude Modulation (QAM)
	Bell 212A, 1200 bps, asynchronous, Differential Phase Shift Keying (DPSK)
	Bell 103, 300 bps, asynchronous, Frequency Shift Keying (FSK)
	Microcom Networking Protocol (MNP), Service Levels 1-5 at 2400/1200 bps
	USRobotics proprietary HST protocol at 9600/7200/4800 bps, similar to MNP Levels 1-5, adapted for asymmetrical modulation
	RS-232C terminal/modem interface
	Superset of industry standard AT command set, S-registers, DIP switches
Online data rate fallback	7200, 4800 bps
Phone Line Interface	RJ11, RJ12, RJ13, RJ41, RJ45 phone jacks
Communications Channel	Full/half duplex on 2-wire dial-up, dedicated, or leased phone lines, demand-driven high speed channel turnaround
Data Rates	300, 1200, 2400, 9600 bits per second
Operational Modes	Auto Dial/Answer, Manual Originate/Answer

Dialing

Rotary (pulse 0–9), Touch-Tone (DTMF 0–9, #, *), a-z when in Quote (‘‘) Mode

Data Format

Binary, serial, asynchronous; defaults to 7-bit word length, even parity

Start Bits	Data Bits	Parity	Stop Bits
1	7	Even, Odd, Mark, Space	1
1	7	None, Even, Odd, Mark, Space	2
1	8	None	1,2

Front Panel Indicators

HS	High Speed (9600 bps)
AA	Auto Answer/Answer
CD	Carrier Detect
OH	Off Hook
RD	Receive Data
SD	Send Data
TR	Terminal Ready (DTR)
MR	Modem Ready/Power
RS	Request to Send
CS	Clear to Send
ARQ	Error control connection established
AL	Analog Loopback Self-Test

Programmable S-Registers

Values in parentheses are defaults:

Number of rings on which to answer (1)
ASCII character definitions, decimal: escape code (43), Carriage Return (13), Line Feed (10), Backspace (8)
Timing: Wait before dialing (2 sec)
Carrier Detect wait (30 sec)
Pause in Dial, Repeat commands (2 sec)
Remote Carrier Detect before local recognition (0.6 sec)
Disconnect at loss of carrier (0.7 sec)
Escape code guard time (1 sec)
Touch-Tone duration, spacing (70 Ms)
Break length, to DTE (100 Ms)
Disable MNP Levels 3, 4
Disable 450-bps back channel, force 300 bps
Optional non-error control Transmit buffer size

Programmable S-Registers (Cont.)	Auto Dial stored phone number on DTR, reset or power on Answer in Originate Mode Modem self-testing (0, Data Mode) Inactivity Timer (0, disabled)
Switch Functions	Externally accessible. Values in parentheses are factory settings: UP = OFF (open), DOWN = ON (closed). Volume control DTR override (DOWN) Result code mode (UP, verbal) Result code display (DOWN, displayed) Command Mode echo (UP, echo ON) Auto Answer (DOWN, AA suppressed) CD override (DOWN) RJ11/RJ13 jack (UP, RJ11) Smart/Dumb mode (DOWN, Smart) Online Escape code with/without disconnect (DOWN, no disconnect) Load NRAM defaults/ROM factory settings (UP, NRAM) RS-232C Modem/Terminal data interface (UP, normal assignments of Pins 2 and 3)
Flow Control Buffers	Transmit Buffer: Error control: 3.5k bytes Non-Error control: 1.5k bytes, 128-byte option Receive Buffer: 2k bytes
Command Buffer	40 characters, exclusive of AT prefix, Carriage Return and spaces
Control Commands	User-programmable nonvolatile memory (NRAM) Data compression enabled/disabled Fixed/variable DTE and link rates Error control enabled/disabled Error control result codes enabled/disabled Transmit data flow control (hardware, software) Received data flow control (hardware, software) Command mode, online echoing Verbal/numeric result codes Standard, Extended, Advanced result code sets Result code display ON/OFF Speaker OFF, ON until CD, ON through CD and data transmission, ON after last digit dialed until CD Command Mode/online toggle

Control Commands (Cont.)	Voice/data communications Adaptive dialing Fast dialing, search for dial tone Wait for second dial tone, then continue Wait for answer, then continue Dial alphabetic string Dial one of four phone numbers stored in NRAM Flash switch-hook to transfer call Reset to NRAM defaults Load ROM factory settings Request to Send (RTS) override Data Set Ready (DSR) override Break handling
Test Options	Analog loopback (2400/1200/300 bps) Dial test Test pattern (2400/1200 bps) Analog loopback with test pattern (2400/1200 bps)
Call Progress Codes	NO DIAL TONE BUSY NO ANSWER RINGING VOICE
Equalization	Adaptive
Transmitter Carrier Frequencies	USR-HST Originate Mode: 350 Hz Answer Mode: 1800 Hz V.22*bis*, Bell 212A Originate Mode: 1200 Hz Answer Mode: 2400 Hz Bell 103 Originate Mode: Mark: 1270 Hz Space: 1070 Hz Answer Mode: Mark: 2225 Hz Space: 2025 Hz

Receiver Carrier Frequencies:	USR-HST Originate Mode: 1800 Hz Answer Mode: 350 Hz V.22*bis*, Bell 212A Originate Mode: 2400 Hz Answer Mode: 1200 Hz Bell 103 Originate Mode: Mark: 2225 Hz Space: 2025 Hz Answer Mode: Mark: 1270 Hz Space: 1070 Hz
Certification	FCC Part 68 & Part 15, Subpart J, Class B Domestic; DOC (Canada)
Power Adapter	UL listed, CSA approved, Supply voltage: 115 VAC, 60 Hz, 16 VAC Output
Power Consumption	10 watts
Failed Call Timeout	30-sec. default, programmable 2–255 sec.
Answer Tone Timeout	30 sec.
Answer Tone Detector	2150–2300 Hz
Loss of Carrier Timeout	(Disconnect Timer) 0.7-sec. default, programmable 0.2–25.5 sec.
Receive Sensitivity	-43 dBm
Transmit Level	- 9 dBm
Transmitter Frequency Tolerance	.01 %
Size	8.30 x 12.65 x 1.57 inches

Cross-references in the following definitions are printed in boldface.

Analog Loopback — A modem self-test in which data from the keyboard is sent to the modem's transmitter, modulated into **analog** form, looped back to the receiver, demodulated into **digital** form, and returned to the screen for verification. Tests either the modem's originate or answer frequency.

Analog Signals — Continuous, varying waveforms such as the voice tones carried over phone lines. Contrast with **digital signals.**

Answer Mode — A state in which the modem transmits at the predefined high frequency of the communications channel and receives at the low frequency. The transmit/receive frequencies are the reverse of the calling modem which is in **Originate Mode.**

ARQ — Automatic Repeat Request. A general term for error control protocols which feature error-detection and automatic retransmission of defective blocks of data. ➤ See **HST** and **MNP.**

ASCII — American Standard Code for Information Interchange. A 7-bit binary code (0s, 1s) used to represent letters, numbers, and special characters such as $, !, and /. Supported by almost every computer and terminal manufacturer. ➤ See Appendix B-6 for decimal and hexadecimal code equivalents.

Asynchronous Transmission — Data transmission in which the length of time between transmitted characters may vary. Because the time lapses between transmitted characters are not uniform, the receiving modem must be signaled as to when the data bits of a character begin and when they end. The addition of Start and Stop bits to each character serves this purpose. Compare **Synchronous Transmission.**

Auto Answer — A feature in modems enabling them to answer incoming calls over the phone lines without the use of a telephone receiver.

Auto Dial — A feature in modems enabling them to dial phone numbers over the phone system without the use of a telephone transmitter.

Baud Rate — The number of discrete signal events per second occurring on a communications channel. Although not technically accurate, baud rate is commonly used to mean **bit rate.**

Binary Digit — A 0 or 1, reflecting the use of a binary numbering system (only two digits). Used because the computer recognizes either of two states, OFF or ON. Shortened form of binary digit is "bit."

Bit Rate — The number of **binary digits** or bits transmitted per second (**bps**). Communications channels using telephone channel modems are established at set bit rates, commonly 110, 300, 1200, 2400, 4800, 9600, and 144000.

BPS — The bits (**binary digits**) per second rate.

Buffer — A memory area used as temporary storage during input/output operations. Two examples in the Courier HST are the command buffer (last issued command) and the flow control buffer (for data flow control and storing copies of transmitted **frames** until they are positively acknowledged by the receiving modem).

Byte — A group of **binary digits** stored and operated upon as a unit. A byte may have a coded value equal to a character in the ASCII code (letters, numbers), for example, or have some other value meaningful to the computer. In user documentation, the term usually refers to 8-bit units or characters. 1 kilobyte = 1,024 bytes or characters; 64k = 65,536 bytes or characters.

Carrier — A continuous frequency capable of being either modulated or impressed with another information-carrying signal. Carriers are generated and maintained by modems via the transmission lines of the telephone companies.

CCITT — An international organization that defines standards for telegraphic and telephone equipment. For example, the Bell 212A standard for 1200 bps communication in North America is observed internationally as CCITT V.22. For 2400 bps communication, most U.S. manufacturers observe V.22*bis*. The initials CCITT represent the French name; in English it's known as the International Telegraph and Telephone Consultative Committee.

Character — A representation, coded in **binary digits**, of a letter, number, or other symbol.

Characters Per Second — A data transfer rate generally estimated from the bit rate and the character length. For example, at 2400 bps, 8-bit characters with Start and Stop bits (for a total of ten bits per character) will be transmitted at a rate of approximately 240

characters per second (cps). Some protocols such as USR-HST and MNP employ advanced techniques to increase cps up to 19.2k bps. See "MNP Level Negotiation" in Appendix A for more information.

Cyclic Redundancy Checking (CRC) An error-detection technique consisting of a cyclic algorithm performed on each block or **frame** of data by both sending and receiving modems. The sending modem inserts the results of its computation in each data block in the form of a CRC code. The receiving modem compares its results with the received CRC code and responds with either a positive or negative acknowledgment. In the ARQ protocol implemented in the Courier HST, the receiving modem accepts no more data until a defective block is received correctly.

Data Communications A type of communications in which computers and terminals are able to exchange data over an electronic medium.

DCE Data Communication (or Circuit-Terminating) Equipment. In this manual, the dial-up modems that establish and control the data link via the telephone network.

DTE Data Terminal (or Terminating) Equipment. The device, such as a personal computer, terminal, or mainframe, that generates or is the final destination of data.

Dedicated Line Often used to describe a user-installed phone line, or one leased from the telephone company, that provides a continuous point-to-point connection between two modems, hence "dedicated" to those two devices. The line is "non-switched": the connection does not require dialing into the phone company's central switching equipment.

Default Any setting assumed, at startup or reset, by the computer's software and attached devices, and operational until changed by the user.

Digital Signals Discrete, uniform signals. In this manual, the term refers to the **binary digits** 0 and 1.

Duplex Indicates a communications channel capable of carrying signals in both directions. ➤ See **Half Duplex**, **Full Duplex.**

Equalization A compensation circuit designed into modems to counteract certain distortions introduced by the telephone channel. Two types are used: fixed (compromise) equalizers and those that adapt to channel conditions.

Error Control — Various techniques which check the reliability of characters (**Parity**) or blocks of data. The Courier's error control protocol provides error control through error detection (**CRC**) and retransmission of errored frames (**ARQ**).

Flow Control — A mechanism that compensates for differences in the flow of data input to and output from a modem or other device.

Frame — A data communications term for a block of data with header and trailer information attached. The added information usually includes a frame number, block size data, error-check codes, and Start/End data.

Full Duplex — Signal flow in both directions at the same time. In microcomputer communications, may refer to the suppression of the online **Local Echo**. The receiving computer may provide a **Remote Echo**.

Half Duplex — Signal flow in both directions, but only one way at a time. In microcomputer communications, may refer to activation of the online **Local Echo**, which causes the modem to send a copy of the transmitted data to the screen of the sending computer.

HST — High Speed Technology, part of the trademark for USRobotics' USR-HST, a proprietary signaling scheme, design and protocol for 9600 bps modems. USR-HST incorporates trellis-coded modulation, for greater immunity from variable phone line conditions, and asymmetric modulation for more efficient use of the phone channel. HST also represents the enhanced error control protocol at 9600 bps that is similar to and compatible with **MNP** error control at 2400/1200 bps.

Local Echo — A modem feature that enables the modem to send copies of keyboard commands and transmitted data to the screen. When the modem is in Command Mode (not online to another system) the local echo is invoked through the ATE1 command. The command causes the modem to display your typed commands. When the modem is online to another system, the local echo is invoked through the ATF0 command. This command causes the modem to display the data it transmits to the remote system.

MNP — Microcom Networking Protocol. An **error control** protocol developed by Microcom, Inc. and now in the public domain. The protocol ensures error-free transmission at

1200 and 2400 bps through error detection (**CRC**) and retransmission of errored **frames**.

Modem

A device that transmits/receives computer data through a communications channel such as radio or telephone lines. The Courier is a telephone channel modem that modulates, or transforms, **digital signals** from a computer into a form that can be carried successfully on a phone line. It also demodulates signals received from the phone line back to digital signals before passing them to the receiving computer.

Intelligent modems with built-in software, such as the USRobotics modem described in this manual, simplify using phone networks for data communications.

Nonvolatile Memory (NRAM)

User-programmable random access memory whose data is retained when modem power is turned off. Used in the Courier HST to store a user-defined default configuration loaded into random access memory (**RAM**) at power on.

OFF/ON Hook

Modem operations which are the equivalent of manually lifting a phone receiver (taking it off hook) and replacing it (going on hook).

Originate Mode

A state in which the modem transmits at the predefined low frequency of the communications channel and receives at the high frequency. The transmit/receive frequencies are the reverse of the called modem which is in **Answer Mode**.

Parallel Transmission

The transfer of data characters using parallel electrical paths for each bit of the character, for example, 8 paths for 8-bit characters. Data is stored in computers in parallel form, but may be converted to serial form for certain operations.
➤ See **Serial Transmission**.

Parity

An error-detection method that checks the validity of a transmitted character. Character checking has been surpassed by more reliable and efficient forms of block-checking, including XMODEM-type public domain protocols used in some telecommunications software, and the enhanced **ARQ** protocols implemented in the Courier HST.

The same type of parity must be used by two communicating computers, or both may omit parity. When parity is used, a parity bit is added to each transmitted character. The bit's value is 0 or 1, to make the total number of 1s in the

character even or odd, depending on which type of parity is used.

Protocol — A system of rules and procedures governing communications between two or more devices. Protocols vary, but communicating devices must follow the same protocol in order to exchange data. The format of the data, readiness to receive or send, error detection, and error handling are only a few of the operations defined in a protocol.

RAM — Random Access Memory. Memory that is available for use when the modem is turned on and clears of all information when the power is turned off. The Courier HST's RAM holds the current operational settings, a flow control **buffer**, and a command buffer.

Remote Echo — A copy of the data received by the remote system, returned to the sending system and displayed on the screen. Remote echoing is a function of the remote system.

ROM — Read Only Memory. Permanent memory, not user-programmable. The Courier HST's factory settings are stored in ROM and can be read (loaded) into RAM as an operational configuration.

Serial Transmission — The transfer of data characters one bit at a time, sequentially, using a single electrical path. ➤ See **Parallel Transmission**.

Start/Stop Bits — The signaling bits attached to a character before the character is transmitted during **Asynchronous Transmission**.

Synchronous Transmission — A form of transmission in which groups of data bits are sent at regular intervals. Because the timing is uniform, no **Start** or **Stop bits** are required. ➤ See **Asynchronous Transmission**.

Terminal — A device whose keyboard and display are used for sending and receiving data over a communications link. Differs from a microcomputer in that it has no internal processing capabilities. Used to enter data into or retrieve processed data from a system or network.

Terminal Mode — An operational mode required for microcomputers to transmit data. In Terminal Mode the computer acts as if it were a standard terminal such as a teletypewriter, rather than a data processor. Keyboard entries go directly to the modem, whether the entry is a modem command or data to be

transmitted over the phone lines. Received data is output directly to the screen. The more popular communications software products control Terminal Mode as well as enable more complex operations, including file transmission and saving received files.

Throughput — The amount of actual user data transmitted per second without the overhead of protocol information such as Start and Stop bits or **frame** headers and trailers. Compare **characters per second**.

Transmission Rate — Same as **Bit Rate**.

V.22*bis* — The international **CCITT** standard for modem communications at 2400 bps. The standard includes an automatic data rate fallback to 1200 bps and compatibility with Bell 212A/V.22 modems.

Word Length — The number of bits in a character without parity, start or stop bits.

XON/XOFF — Standard **ASCII** control characters used to tell an intelligent device to stop/resume transmitting data. In most systems typing <Ctrl>-S sends the XOFF character. Some devices, including the Courier, understand <Ctrl>-Q as XON; others interpret the pressing of any key after <Ctrl>-S as XON.

A

A/A1 shorting, DIP switch 7, B-3.2, E-4.1
ACK character, App. E-5
Adaptive dialing, 1-3, 5-4, 6-3
Advanced result code set, 5-3–5-5
Analog loopback self-test, App. E-6
Answer mode
  auto answer, 6-9–6-10
  DIP switch 5, B-3.1
  rate recognition, 4-8, App. E-2
  manual answer, E-1.1, E-4.1
ARQ (Automatic Repeat Request)
  CONNECT result codes (&A), 5-5
  definition, 4-1, A-3
  flow control requirement, 3-2, 4-5
  mode select (&M), 3-1, 4-3–4-4
  operations, A-1–A-4
  timeout, retransmit maximum, 4-2
  with Auto Answer, 4-4
Assembly, modem, 2-2–2-4
  RS-232C cable requirements, 2-2
Aymmetrical modulation, 1-1, 3-2–3-3
Asterisk (*), 6-2
Asynchronous transmission, F-1, Glossary
ASCII Chart, App. B-6
  character definitions, 5-8, B-5.1
Audio monitor (speaker), 5-6–5-7
Auto dialing, 6-1–6-8
  Help screen (D$), 7-6
  quick reference, 3-1
  stored phone numbers, 3-3, 6-7
Auto answering, 6-9
  disabling, 6-10
  number of rings on which to answer (S0), 7-3, B-5.1
  with Dip switch 5, 6-9, B-3.1
Automatic Repeat Request, see ARQ

B

Back channel, 3-2–3-5, F-1
Backspace key, ASCII definition (S5), B-5.1
Baud rate, see Glossary
Bits per second (bps)
  defined, see Glossary
  link negotiation, 3-3, 4-8, A-1–A-3
  online fallback, 1-2, 4-3, F-1
  rate recognition, 4-8, 6-1, App. E-2
  setting the, 3-1, 3-2, 4-8–4-9, 6-1
Break handling (&Y), 5-8
Break length, modem to terminal (S21), B-5.4
Buffers
  command, 6-7
  flow control, 3-2, 4-5, A-4
Busy answer, 3-4, 5-4, 6-6–6-7

C

Calling another modem, 3-1, 6-1–6-8
  at another extension, E-4.1
Call duration reporting (K), 5-7
Call progress messages, 5-3, 5-4–5-5
Canadian certification (DOC), xi, 6-7
Carrier, defined, 5-6
Carrier Detect (CD) override (DIP switch 6), 2-5, B-3.2, D-1
CCITT
  answer tone (B), 6-10
  defined, Glossary
Channel, turnaround, 1-1, 3-2–3-3, F-1
Characters per second (cps), 1-1, A-1
  maximum throughput, 3-2, 4-1–4-2, 4-9
Clear to Send (CTS), 4-5, B-1.1
Clock, Courier (K), 5-7
Command length, C-1
Command mode local echo (E), 2-6, 5-5
Command summary, App. C
Commands
  Adaptive dialing (X2–X6), 5-4, 6-3
  Alphabetical listing, App. C
  Answer mode, manual (A)
    analog loopback self-test, E-6.1, E-6.2
    on dedicated or leased lines, E-4.1
    with voice/data operations, E-1.1
  ARQ mode select (&M), 3-1, 4-3–4-4
  ARQ result codes (&A), 5-5
  AT (attention), 2-5, C-1
  Break handling (&Y), 5-8
  Cancel dialing (any key), 6-6
  Carriage return (<cr>), 2-5, C-1
    ASCII definition (S3), B-5.1
    to enter commands, 2-5
  Comma (pause), 6-3
  Command mode local echo (E), 2-6, 5-5
  Compression, data (&K), 3-1, 4-4, 4-5
  Data rate select, 3-1, 3-2, 4-9, 6-1
    DTE rate (&B), 4-9
    Link rate (&N), 4-9
  Data set ready, DSR (&S), 4-10

Commands, cont.
Dial (D), 3-1, 6-2–6-8
and return to command state (;), 6-4
letter strings (''), 6-5
Help screen (D$), 7-6
stored phone number (DS), 3-4, 6-7
Disconnect (H, + + +), 6-8, 6-9
Disable transmitter (C), 5-7
Duplex, 5-6
Echo, local (E, F), 2-5, 5-6
Escape code (+ + +), 6-8, 6-9
Factory settings, loading (&F), 5-2
Flow control, 3-2, 4-5–4-7
received data (&I, &R), 4-6–4-7
transmit data (&H), 3-1, 4-5–4-6
Hang up (H, + + +), 6-9, 6-10
Help screens, using, 7-4
ampersand commands (&$), 7-5
basic commands ($), 7-4
dialing (D$), 7-6
S-register functions (S$), 7-6
HST mode select (&M), 3-1, 4-3–4-5
Inquiry options (I), 7-1
call-duration (I3), 5-7, 7-1
current settings display (I4), 7-2
link diagnostics display (I6), 7-3
NRAM settings display (I5), 7-2
Local echo (E, F), 2-6, 5-5, 5-6
MNP mode select (&M), 3-1, 4-3–4-4
Online local echo (F), 5-6
Pulse dial make/break ratio (&P), 6-11
Pulse/Touch-Tone dial (P/T), 6-2
Quiet mode (Q), 5-5
Receive only, disable transmitter (C), 5-7
Received data flow control (&I, &R), 4-6, 4-7
Redial/reexecute previous command
one time (A/), 3-4, 6-7
continuous, (A>), 3-4, 6-7
Repeat, continuous (>), 3-4, 6-7
Reset to NRAM defaults (Z), 5-2
Response modes (V), 5-3
Result code sets (X), 5-3–5-5
Return online after + + + (O), 6-9
Reverse frequencies (R), 6-6
Save in NRAM
modem settings (&W), 5-1
phone numbers (&Zn=s), 5-2
Settings status display
current settings (I4), 7-2
NRAM settings (I5), 3-3, 5-1, 7-2
Speaker control (M), 5-6–5-7
S-register settings (Sr=n), B-5.1
query specific register (ATSr?), 4-3, 7-3
Touch-Tone/pulse dial (P/T), 6-2
Transfer call (!), 6-5
Transmit data flow control (&H), 3-1, 4-5
Verbal/numeric response modes (V), 5-3
Wait for second dial tone (W), 6-5
Wait for answer (@), 6-5
Write to NRAM
modem settings (&W), 5-1
phone numbers (&Zn=s), 5-2
Compatibility, 1-3, 6-1, F-1
error control, 3-1, 4-1
Compression, see Data compression
Computer interface (DTE) speed select (&B), 4-9
Configuration, general
DIP switches, 2-4, App. B-3
factory defaults, 5-2, App. B-4
interface controls, Ch. 4
internal controls, Ch. 5
NRAM options, 5-1, App. B-4
physical assembly, 2-2–2-4
S-registers, App. B-5
Configuration to call:
HST-compatibles, 3-1
MNP-compatibles, 3-1
non-MNP compatibles, 3-2
CONNECT messages, 5-3, 5-4, App. E-2
ARQ (&A), 5-5
Connection rate, 3-3, 4-8, E-2.1
negotiation, 3-3, 4-8, E-2.1
Connectors, DTE interface
requirements, 2-1–2-2
physical assembly, 2-4
RS-232C interface definitions, App. B-1
CRC, cyclic redundancy checking, A-4
CTS, 4-5, B-1.1
Customer service, USRobotics, viii, D-4

D

Data compression (&K), 1-1, 3-1, 3-2, 4-4, 4-5
Data format, 6-1, F-1
Data rate
link negotiation, 3-3, 4-8, A-1–A-3
online fallback, 1-2, 4-3, E-2.3, F-1
setting the, 3-1, 3-2, 4-8–4-9, 6-1
Data rate select,
DTE rate (&B), 4-9
guidelines, 4-8
link rate (&N), 4-9
Data Set Ready (DSR) override (&S), 4-10, B-1.1

Data Terminal Ready (DTR) override (DIP switch 1), 2-5, B-1.1, B-3.1, D-1
DCE, defined, 4-1
Defaults, 5-2, App. B-4, App. C
Diagnostics
call/link, 7-3
testing, 2-5, 7-1, App. E-6
Dial, auto
at a glance, 3-1–3-2
commands, functions, 6-2–6-8
stored phone number (DSn), 3-3, 6-7
Dialing type
adaptive, 1-3, 5-4, 6-3
pulse/tone, 6-2
Department of Communications (DOC), xi, 6-7
Digital signals, see Glossary
DIP switches, 2-4, App. B-3
auto answer, 6-9
CD override, D-1, D-2
disconnect/hang up, 6-8
DTR override, D-1
escape code operations, 6-8
load options, 3-3, 5-1, 5-2
local echo, 2-6, 5-5
result code display (quiet mode), 5-5, D-1, D-2
Result codes verbal/numeric, 5-3, D-1
Single/multiphone installation, E-4.1
Disconnecting (H, + + +), 6-8, 6-9
reasons (S17, S20), 7-3, B-5.4
DOC, xi, 6-7
DTE, defined, 4-1
speed select (&B), 4-9
DSR override (&S), 4-10
DTR, Data Terminal Ready, B-1.1, B-3.1, D-1
dropping to force disconnect, 6-8
Dumb mode (DIP switch 8), B-3.2
Duplex, Half/Full, 5-6

E

Echo, local 2-6, 5-5, 5-6
ENQ character, App. E-5
Error checking, A-3
Error control, using, 3-1, 3-2, 4-3–4-4, 4-5, 6-1
ERROR message, 5-4
Escape code (+ + +), 6-8, 6-9
changing ASCII definition (S2), 6-8, B-5.1
to terminate analog loopback test, E-6.3
Extended result code set, 5-3, 5-4, App. E-2
Extensions
calling another, E-4.1
transferring calls to (!), 6-5

F

Factory settings, 5-2, App. B-4
Fallback, data rate
link negotiation, 3-3, 4-8, A-1–A-3
online, 1-2, 4-3, F-1
FCC certification, ix
Fixed/variable rates, 3-3, 4-8, 4-9
Flow control, 3-2, 4-5–4-7
Frame transmission, A-3–A-4
Full duplex, 5-6

G

Guard tone (&G), 6-10

H

Half duplex, 5-6
Hanging up (H, + + +), 6-8, 6-9
reasons (S20), 7-3, B-5.4
Help screens, see list under "Commands"
Hewlett Packard installations, 2-2, 4-7, App. E-5
HST (High Speed Technology)
features, 1-1
error control modes, 3-1, 4-3

I

Inactivity timeout (S19), 1-2, 3-4, B-5.4
Indicator lights, 2-5, App. B-2
Inquiry (I) options, 7-1–7-3
Installation, 2-2–2-4

L

Leased line installation, operations, E-4.1
LED indicators, 2-5, App. B-2
Line feed, ASCII definition (S4), B-5.1
Link interface
disconnect reasons (S17, S20), 7-3, B-5.4
operations, 3-3, 4-8, A-1–A-3, App. E-2
speed select (&N), 4-9
Load number, DOC, xi
Local echo, 2-6, 5-5, 5-6
Loopback, analog, App. E-6

M

Manual, how to use, xii
Memory, modem
nonvolatile random access (NRAM), 3-3, 5-1–5-2, App. B-4
random access (RAM), 7-1, see Glossary
read only (ROM), 5-2, 7-1, see Glossary

MNP, Microcom Networking Protocol, 1-1, 4-1, App. A (also see ARQ)
Service levels, A-1–A-3
Modem
defaults, App. B-4, App. C
defined, Glossary
installation, 2-2–2-4
problems and solutions, App. D
repair, viii, D-3
Modulation, 1-1, F-1
Multiphone installations (DIP switch 7), B-3.2, E-4.1

N

NO ANSWER result, 5-4, 5-5 6-6
NO CARRIER result, 5-4, 6-9
reason (S20), 4-2–4-3, 7-3, B-5.4
NO DIAL TONE result, 5-4, E-1.1, E-4.1, E-6.1
Nonvolatile random access memory (NRAM)
configuring, 5-1, App. B-4
defined, 5-1
options, App. B-4
resetting to (Z), 5-2
writing to (&W, &Zn=s), 3-3, 5-1, 5-2

O

OK message, 2-5, 5-4
Online local echo, 5-6
Operations
auto answer, 6-10
auto dial, 6-1–6-8
error control, 3-1, 4-3–4-4, 4-5, 6-1
flow control, 3-2, 4-5–4-7
Originate mode, 2-6, 6-2, E-1.1, E-4.1, E-6.1, E-6.2

P

Parity, 6-1
defined, Glossary
Party lines, ix
Pause during dial (,), 6-3
Phone company, connecting to, ix
Phone line interface, 2-4, F-1
dedicated or short line, E-4.1
multiphone (DIP switch 7), B-3.2, E-4.1
PBX installations
DIP switch 7, B-3.2
procedures, E-4.1
Phone jacks
on Courier, 2-4
RJ11C (single phone), 2-1, B-3.2
RJ12, RJ13 (multiphone), B-3.2, E-4.1
Phone number storage (&Zn=s), 3-3, 5-2
Placing a call, 3-1, 6-2–6-8
Pound sign (#), 6-2
Problems
and solutions, App. D
ARQ compatibility (S17), 7-3, B-5.4
Programming rate switching, App. E-2
Pulse dialing, 6-2, 6-11

Q

Quiet mode, 5-5, D-1, D-2

R

Radio/television interference, x
RAM, random access memory, 7-1, see Glossary
Rate select commands
DTE rate (&B), 4-9
link rate (&N), 4-9
guidelines, 4-8
Rate switching, 1-2, 3-2, 3-3, 4-8, App. E-2
link negotiation, 3-3, 4-8, A-1–A-3
online fallback, 1-2, 4-3, E-2.3, F-1
Received data flow control (&I, &R), 4-6, 4-7
Redial/reexecute,
continuous (A>), 6-7
one time (A/), 6-7
Remote echo, 5-6
Repeat mode commands (>, A>), 6-7
Request to Send (RTS), 4.6, B-1.1
Requirements, operating, 2-1
9600 bps, 3-1
MNP, 3-1
ventilation, 2-4
Reset to NRAM defaults (Z), 5-2
Response time, 1-1
Result code sets, 5-3–5-5
Retrain sequence, 1-2, 6-2, App. E-3
Retransmission, 3-2, 4-2, A-4
maximum to timeout, 4-2
RING result code, 6-9
RINGING result code, 5-4
RJ11C jack, 2-4, B-3.2
RJ12/RJ13 jack (multiphone line), B-3.2, E-4.1
RMA (Return Materials Authorization) number, viii, D-4
ROM, read only memory, 5-2, 7-1
defined, Glossary
RS-232C interface, App. B-1
CD override (Pin 8, DIP switch 6), B-2.1, B-3.2, D-1, D-2
connectors, 2-2, 2-4
CTS (Pin 5, &H), 4-5
DSR override (Pin 4, &S), 4-10
DTR override (Pin 20), B-2.1, D-1
RTS (&R), 4-6

S

Serial transmission, see Glossary
Settings
    default, App. B-4, App. C
    interface, Ch. 4
    internal, Ch. 5
    quick reference, Ch. 3
Shorting A/A1, multiphone lines, B-3.2, E-4.1
Speaker (audio monitor), 5-6
Speed recognition, 4-8, 6-1, App. E-2
Speed select
    DTE rate (&B), 4-9
    link rate (&N), 4-9
S-registers, 5-8, 7-3, App. B-5
Standards
    Courier compatibility with, 1-3, 6-1, F-1
    RS-232C, App. B-1, B-3.2
Start/Stop bits, 6-1, F-1
Store phone number (&Zn), 3-3, 5-2

T

Technical Specifications, App. F
Technical Support, USRobotics, viii, D-4
Telephone company, connecting to, ix
Television/radio interference, x
Terminal (DTE) interface speed select (&B), 4-9
Terminal Mode, 2-2, 2-5
Terminology, 4-1, Glossary
Testing, 2-5, App. E-6
Throughput, 1-1, 3-2, 4-1–4-2, 4-8, A-1, A-2
Touch-tones
    dialing, 6-2
    timing, spacing (S11), B-5.2
Transmission rate, 3-1, 3-2, 4-8, 6-1, App. E-2
    DTE interface (&B), 3-3, 4-9
    link interface (&N), 3-3, 4-9
Transmit data flow control (&H), 3-1, 3-2, 4-5–4-6, 4-3
Trellis coded modulation, 1-1
Turnaround, high speed channel, 1-1, 3-2–3-3, F-1

U

Unattended operation, 6-8–6-9
United Kingdom requirements
    CCITT answer sequence, 6-10
    Guard tone enabled, 6-10
    Pulse dial make/break ratio, 6-11

V

Variable/fixed data rates, 4-8
    DTE interface (&B), 3-3, 4-9
    link interface (&N), 3-3, 4-9
Ventilation, 2-4
Voice/data communications
    configuring for, 2-4
    using both, App. E-1

W

Warranty information, viii
Word length, 6-1, F-1

X

XMODEM-type protocols, 4-2, 4-5, B-5.3

Y

YMODEM, 4-2, 4-5, B-5.3

Z

ZMODEM, 4-2

NOTES

NOTES

NOTES

Printing 9 8 7 6 5 4

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